THE JOURNAL

OF THE

Quekett

MICROSCOPICAL CLUB.

EDITED BY

EDWARD MILLES NELSON

AND

DAVID J. SCOURFIELD.

SECOND SERIES.

VOLUME VII.

1898-1900.

London:

[PUBLISHED FOR THE CLUB]

WILLIAMS AND NORGATE,

14, HENRIETTA STREET, COVENT GARDEN, LONDON,
AND 20, SOUTH FREDERICK STREET, EDINBURGH.

PRINTED BY

HAZELL, WATSON, AND VINEY, LD.,

LONDON AND AYLESBURY.

CONTENTS.

PART No. 42, APRIL 1898.

Papers.

Proceedings, etc.

Reviews.

PART No. 43, NOVEMBER 1898.

Papers.

Note.

Proceedings.

PART No. 44, APRIL 1899.

Papers.

Note.

Proceedings, etc.

Reviews.

PART No. 45, NOVEMBER 1899.

Papers.

Note.

Proceedings.

Reviews.

PART No. 46, APRIL 1900.

Papers.

Notes.

Reviews.

Proceedings, etc.

PART No. 47, NOVEMBER 1900.

Papers.

Notes.

Reviews.

Proceedings, Etc.

LIST OF ILLUSTRATIONS.

PLATES.

FIGURES IN THE TEXT.

FIGURES IN THE TEXT—*continued.*

Evolution of the Basidiomycetes.

By George Massee.

(*Read November 19th*, 1897.)

The following *résumé* of a talk on the subject embodied in the above title will, I fear, convey but a very imperfect idea of the substance of an originally imperfect discourse; which, if it contained anything of interest, was dependent on a series of illustrations which unfortunately cannot be reproduced.

The fungi as a group, in its highest stage of differentiation, must be considered as comparatively modern. On the other hand, its oldest members are undoubtedly even geologically ancient. Fungi almost if not quite indistinguishable from species living at the present day, have been found in fragments of *Lepidodendron* from the coal measures, and undoubted fungi are known from even older geological formations. These fungi, however, belong to the pioneers of the fungal group, which, from the present standpoint of science, is considered as being derived from the Algæ. The oldest forms of fungi are truly aquatic, and differ mainly from certain Algæ, as *Vaucheria*, etc., in being destitute of the green colouring-matter called chlorophyll. Now this deprivation necessitated the presence of organic food, hence the earliest known fungi—or algæ deprived of chlorophyll—are met with as *saprophytes*, living on dead organic matter, or as *parasites*, deriving food from living organisms. The latter section, the most abundant in early times, were parasitic in the tissues of various algæ and other aquatic plants and animals. Gradually these parasites and saprophytes forsook their primordial home, and adapted themselves to a life on dry land. Up to this period there was but little morphological differentiation between the newly evolved group and its algal ancestors, save in the matter of chlorophyll, already alluded to; but on taking possession of the dry land as their future abode, a new morphological factor

was gradually evolved, which in course of time completely superseded the original structure, and gave to the fungi an individuality which enabled them to rank as a distinct group; so different from their original condition that, but for the unbroken chain of connection with ancestral types, could not possibly have been traced back.

This addition to their original structure consisted in the gradual evolution of a second mode of reproduction, which has come to be known as the *conidial* phase, in the life cycle of the individual: a phase or condition quite supplementary to the original form of reproduction, as presented by the Saprólegnieae, Peronosporæ, and other ancient forms of fungal life. As a rule the conidial condition is the first to appear, and continues to produce in rapid succession, and in innumerable numbers, throughout that portion of the season during which conditions are favourable for the rapid growth of the fungus, very minute, asexually produced reproductive bodies called *conidia*. These conidia are capable of germination the moment they are mature, and being readily dispersed by wind and other agents, those that happen to alight on the proper substance germinate at once, thus forming a new centre for the production of conidia, which are often produced within a week of the period of infection. By this method of reproduction the fungus is enabled to rapidly extend its geographical area, provided sufficient of the special matrix required by the fungus is present within the range of dispersion of its conidia. From the above account it can be readily understood how quickly a fungous disease spreads when it has once gained a foothold, especially in those cases where the food-plant or *host* occurs in great abundance,—for example, in a field of corn, potatoes, etc. If farmers and horticulturalists would only grasp this fact, and act in conformity with ascertained laws, the numerous ravages caused by fungi, entailing a loss of millions of pounds annually, would cease to exist in proportion to the intelligence employed in securing the desired object. However, to return to the subject directly under consideration: towards the wane of the season of activity on the part of the fungus, the mycelium, or spawn, which earlier in the season produced conidia, now gives origin either directly or indirectly to the higher or primordial type of fructification. The spores belonging to the last-named stage require a period of rest

before they are capable of germination; thus tiding the fungus over that period of the year unsuited for its active growth, germinating during the spring following their formation, at the time when the host-plant has appeared, when inoculation takes place, and the cycle of development of the fungus commences anew, with the formation of the conidial stage.

The conidial condition of numerous fungi are popularly known as mildews, moulds, rusts, etc.; and the point of greatest importance to remember is the fact that these conidial forms, by gradual differentiation, gave origin to the enormous assemblage of fungi known as the Basidiomycetes; the older sexual form of reproduction being entirely suppressed.

The enormous assemblage included in the Basidiomycetes, numbering about eleven thousand species, and embracing almost every conceivable range in size, form, colour, and texture—from the minute cobweb-like structure of some species of *Corticium*, to the gigantic puff-ball, often more than a foot in diameter, and the complex structure of the gill-bearing agarics—all betray a common origin in retaining the exact type of spore-bearing structure, called *basidia*, present in the most primitive types of the group. These basidia are simply the swollen tips of ordinary hyphæ or branches of mycelium, and are club-shaped; the free, rounded end of each basidium usually bears four slender spines or *sterigmata*, each sterigma in turn producing a spore at its tip. The basidia are packed in immense numbers side by side, forming a continuous surface called the *hymenium*, which in course of time becomes covered with spores borne by the sterigmata springing from the swollen tips of the basidia, which collectively form the surface of the hymenium. The surface of the gill of an agaric is covered with a structure of this kind, and the gradual change of colour observed in the gills of some agarics—as in the common mushroom, where the change is from white, through pink, to dark brown—is due to the gradual ripening of the spores. All spores are colourless at first, and in some groups remain permanently so; in other groups the wall of the spore gradually changes colour, until at maturity it is salmon-colour, rust-colour, purple, or black, depending on the particular species.

In briefly tracing the evolution of one section of the Basidiomycetes, called Hymenomycetes, characterised by having the hymenium exposed from the earliest period of its formation,

attention will be chiefly directed to three leading ideas, which have been persistently followed, and the gradual perfection of which has resulted in the building up of the Agaricinæ, the most modern group, at the same time the most perfectly adapted to existing requirements, as proved by its universal distribution and immense numbers.

The points are: (1) The production of the largest area of hymenium or spore-bearing surface, with the least possible expenditure of material; (2) The protection of the hymenium from rain, dust, etc.; (3) The protection of the spore-bearing structure from living enemies, and the facilitation of spore dispersion. The gradual evolution of these points will be compared and contrasted in the following families of the Hymenomycetes:—Clavarieæ, Thelephoreæ, Hydneæ, Polyporæ, Agaricinæ.

Clavarieæ.—The oldest type, and consequently showing the least amount of differentiation, although within the group itself there is a marked advance in the perfection of those ideas which are so pronounced in the higher families. In *Clavaria*, the central genus of the group, the simplest forms consist of a cobweb-like spreading mycelium, from which minute, club-shaped, erect *sporophores* or fertile portions spring, every portion of which is covered by the hymenium or spore-bearing structure. In other species the clubs are larger, but still simple or typically club-shaped—hence the name of the group. In one British species—*Clavaria pistillaris*, the clubs or individual plants are four to seven inches high and often more than an inch in diameter at the thickest part. The special point of progress observable in this group consisted in the gradual modification of the original simple club-shaped sporophore into a branched one, and this idea is carried to the extreme in such species as *Clavaria abietina* and *C. coralloides*, where the fungus resembles a much-branched tree in miniature, the numerous slender branches being everywhere covered by the hymenium; and although in the two last-named species the weight of an entire specimen is much less than of *Clavaria pistillaris*, nevertheless the area of spore-bearing surface is very much greater than in the last-named species, due to the branching of the sporophore. In *Sparassis*, the most highly differentiated genus in the family, the entire structure consists of thin, much contorted plates, entirely covered with the hymenium, the whole resembling, in

general appearance and size, the heart of a curled broccoli plant. There is no attempt to protect the hymenium from rain or dust, the branches standing erect and exposed from the earliest stage of growth. All the species are edible—in other words, there is an entire absence of those alkaloids or other substances injurious to animal life, which are so commonly present in species belonging to the higher families. About three hundred species are known, most grow on the ground, and are most abundant in temperate regions.

THELEPHOREÆ.—The most important feature presented by this family is the gradual evolution of a method for the protection of the hymenium from rain and dust, and the method adopted proved to be so satisfactory that it is followed in all succeeding families. In the most primitive genera, *Hypochnus* and *Corticium*, the entire fungus presents the appearance of a thin crust or layer firmly attached to decaying wood or bark, somewhat resembling a coat of paint or plaster, quite inseparable from the matrix, and having the entire exposed surface covered with the hymenium, which is consequently entirely unprotected, as in the Clavarieæ.

In the genus *Stereum* the first attempt to protect the hymenium is observed; in the simplest forms the entire fungus lies flat and firmly attached throughout to the matrix, as in *Corticium*. In other species the extreme upper margin of the fungus remains free from the matrix, and curves away from the substance on which it is growing. In other species again the free surface is broader and curves away from the matrix, the hymenium, situated on the under surface of the arched portion, being thus protected from rain, dust, etc., falling on its surface. The upper surface of the arched portion of the fungus is sterile, and serves as a protective layer to the hymenium, situated below. Finally, in the highest species of *Stereum* the spore-bearing portion is quite free from the matrix and more or less funnel-shaped, the hymenium being confined to the under surface, pointing to the ground, the upper surface being sterile and protective in function; there is in many species a distinct stem of considerable length. As already stated, the entire energy of the present family appears to have been expended in evolving a method for protecting the hymenium from injury by rain, etc., the idea of adding to the hymenial surface being held in

abeyance, being simply a flat surface, except in the genera *Craterellus* and *Cladoderris*, where it is slightly wrinkled or furnished with imperfect ridges or crests. None of the species are known to be poisonous, but in certain genera, as *Hymenochæte* and *Peniophora*, the hymenium is densely studded with rigid bristles known as *metuloids*, which appear to protect the hymenial surface from being nibbled by mites, as is often the case in genera not thus protected, as *Corticium* and *Stereum*. About one thousand species are known. Distribution cosmopolitan.

Hydneæ.—As in the Thelephoreæ, the species constituting the present family show a sequence from thin, broadly effused expansions, inseparable from the wood or bark on which they grow, through the partly reflexed type, up to the umbrella or mushroom-shaped form having a cap or pileus, fertile on the under surface only, and supported on a centrally placed, distinct stem. The distinctive feature of the present family, viewed from an evolutionary standpoint, consists in introducing a new idea with the object of increasing the area of the hymenium. This idea consisted in covering the spore-bearing portion of the fungus with densely packed, slender teeth, the entire surface of the teeth being fertile, or covered with basidia. In some of the simple, prostrate species, the entire exposed surface of the fungus is covered with teeth or spines not a line long, closely packed and resembling velvet pile; in others the spines are conical and more scattered; whereas in some of the larger species the spines vary from half to one and a half inch in length, and are densely crowded. There is a tendency on the part of the species of *Radulum* and *Irpex* to become tough or woody, and perennial. Some of the species furnish excellent food, amongst which may be included the common British species, *Hydnum repandum*. None are known to be poisonous. A small family, including about one thousand species. Characteristic of the north temperate zone, and most abundant in the forests of Norway and Sweden.

Polyporeæ.—Notwithstanding the large amount of hymenial surface afforded by the spines in the Hydneæ, the idea is strictly confined to that family, and in its place we are confronted with an entirely new conception for effecting the same object in the Polyporeæ, where the hymenium lines the cavities of innumerable very slender tubes, densely packed side by side and cut off at

the same level; hence the hymenium, as seen with the naked eye, appears as if pierced with myriads of pinholes in the majority of species. In some forms the holes or openings of the component tubes are so minute that they cannot be seen with the unaided eye; whereas in the genus *Hexagona* the openings are hexagonal, two to three lines across, and present the appearance of a honeycomb. In all cases the walls of the cavities are studded with projecting basidia bearing spores. The primitive genera, as in *Corticium*, form thin expansions, often of considerable dimensions; then follow numerous species growing on wood under the form of semicircular brackets, bearing the hymenium on the under surface, the upper surface being sterile, frequently scaly or hairy, and often bright-coloured. Finally, numerous species have reached the mushroom type of structure, with a central stem, and having the hymenium protected from the elements by being placed on the under surface of the cap. In addition to this mode of protection, a supplementary protective arrangement is met with in some of the higher species, consisting of a thin membrane reaching from the upper part of the stem to the margin of the cap or pileus; by means of this arrangement the hymenium is entirely concealed from view until the spores are ready for dispersion, when the membrane separates from the margin of the pileus, collapses, and forms a ring round the stem, or in some species it entirely disappears after having fulfilled its protective function. In the genus *Polyporus*, taken in the broad sense, many of the species are woody and perennial, forming a new stratum of pores each season. On the other hand, the species of *Boletus* are all annuals and very fleshy, the pileus in many species resembling a penny bun in shape and size, and supported on a stout stem five to seven inches long and two inches thick. Several kinds of *Boletus* are edible, others contain poisonous alkaloids. About two thousand five hundred species are known. The woody forms occur in both temperate and tropical regions, whereas the soft, fleshy genera, *Boletus* and *Strobilomyces*, are mostly confined to temperate regions, the first-named genus being most abundant in the northern hemisphere, the latter in the southern.

Agaricineæ.—In this, the most modern of the families passed under review, the hymenium occupies the entire surface of very thin plates or lamellæ, popularly known as gills. In the higher forms, as the common mushroom, and the entire category

included under the name of "toadstool," the gills are situated on the under side of the cap or pileus, radiating from a central point round the stem, a given number of the gills extending from the stem to the margin of the pileus, shorter gills occupying the gaps between the primary ones as the margin of the pileus is approached. By this arrangement of closely packed gills, an enormous area of hymenium or spore-bearing surface is furnished at a very small cost of material—certainly very much more than in any of the preceding families. The simplest types of agarics, as illustrated by species of *Pleurotus*, *Marasmius*, and *Cantharellus*, are very minute, often not more than one to two lines across, stemless, with very few, narrow, and widely separated gills, and furthermore, are entirely destitute of protection against climatic influences, the fungus being attached by the pileus, and the gills consequently pointing upwards, without any special covering from the first. Next we meet with forms growing out horizontally from trunks, posts, etc., either stemless or with a short stem springing from the margin of the pileus, and the gills radiating from the point of attachment of the stem in a fan-like manner; in these forms the gills are on the under surface of the pileus. Finally we reach the highest known type of structure, as presented by the common mushroom (*Agaricus campestris*, L.), where we find the cap supported on a central stem and bearing the gills on its under surface. In many of the mushroom type of structure, the gills are protected during the young stage by a membrane stretching from the stem to the margin of the pileus, as described under *Polyporus*. Finally many of the most perfect forms are enclosed in a thick, felt-like sheath or *volva*, which conceals the entire fungus during the period of formation of the various organs, pileus, gills, stem, etc., which takes place underground. When everything is ready the stem elongates rapidly, raising the fungus above ground for the purpose of enabling it to effect the distribution of its spores. As the fungus appears above ground, the volva or sheath, having effected its object, is ruptured, a portion being carried up on the cap, where it persists under the form of irregular patches or warts, so conspicuous on the scarlet pileus of the fly agaric (*Amanita muscaria*), and many other species. Protection against living enemies is very evident in members of the present family, under the form of alkaloids, toxalbumens,

and other poisonous products. The relative superiority of the members of the Agaricineæ in successfully holding their own in the struggle for existence is evidenced by the fact that they are met with in every part of the globe where organic food is present, and that their numbers reach almost to six thousand, or more than that of all the previously mentioned families combined.

On the Generative Organs of Drepanidotænia Venusta (*Tænia Venusta, Rosseter*, 1896).

By T. B. Rosseter, F.R.M.S.

(*Read January 21st*, 1898.)

Plates 1 and 2.

In a paper which I read before the Club at the November meeting in the year 1896, on the discovery of a new Cysticercus and the production of this tape-worm by feeding ducks with the organisms (Entomostraca) which contained it, I purposely refrained from passing any remarks on the anatomy of the creature. I then stated that this, and more especially with reference to the genital organs, would form the subject of a special paper. These latter have now been worked out by me as far as the limited material, owing to the scarcity of the worm, would permit.

The tapeworm which I exhibited on that occasion was an immature one. In this instance, that from which I have prepared my specimens for examination was one of two worms which I reproduced in the early spring of last year (1897) by again feeding ducks from material obtained from Gorstley Wood pond. By this I mean Ostracoda known to be infected, not only with this Cysticercus, but likewise with other Cysticercoids, and from which, besides other tapeworms, I was able to obtain two, and only two, Drepanidotænia (Tænia) Venusta. These were sexually mature. Both of them had passed into that stage when the proglottides of the Strobila have become merely uterine egg-sacs for the developing Oncospheres. One of these I have sealed up, preserving it as a 'type specimen'; the other I have subjected to preparation for the purposes of this paper.

The method employed is simplicity itself when applied to the larger Mammalian Tæniæ, whether of man or animals, such as *Tænia solium*, or *Bothriocephalus latus* of the former; or *Tænia serrata*, or *T. expansa* of the latter. But the technique presents many difficulties in such a case as the present one. I did not

follow the borax-carmine process so strongly recommended by some German investigators, but I hardened with chromic acid, and stained with Ehrlich's acid hæmatoxylin. I find this a better differentiating medium than borax-carmine.

Methods.—I first immersed the tapeworm *en masse* in glycerine diluted with alcohol for forty-eight hours, then washed for a few minutes in a weak alcoholic bath, cut the strobila into pieces and left the severed parts in a ·25 per cent. chromic acid solution for three days, passed them on to methylated spirit for three days (changing the spirit each day), stained with hæmatoxylin, watching them carefully so as not to over-stain; washed in tap-water, embedded in paraffin, cut into sections with microtome, passed through absolute alcohol, cleared with clove oil, and mounted in Canada balsam.

I shall now describe the Scolex, the Strobila, the Generative Organs, both male and female, and the Eggs or Oncospheres.

The Scolex.—The scolex in a fresh specimen has the appearance of a beautifully symmetrical cup or bowl (Fig. 1), with four globular suckers (Fig. 1, *a*) placed equidistantly round it; the upper periphery of each sucker coalescing with the rim of the scolex; and they stand out somewhat prominently in the form of a boss, or protuberance, and so symmetrically are they placed, that when an unprepared scolex is flattened between two plaques of glass it forms a perfect square; and the compressed half-circle of each sucker lies within a triangle whose apex is in the centre of the scolex. Their diameter in flat specimens is 0·280 mm. The rostellum (Fig. 1, *b*) springs from the centre of the bowl. It is a retractile organ, and when everted it is seen to be claviform. Its anterior end is a flat surface from which rises a dome or crown; the dome carries the eight hooks of the scolex, and is much smaller in diameter than the platform on which its base rests. The platform in its natural condition is circular; but in flattened specimens it has the appearance of being angular. The hooks are sickle-shaped, and measure 0·051 to 0·054 mm. The posterior end of the rostellum is attached to and penetrates the cellular parenchymatous tissue of which the scolex is composed, and when everted with the rostellum this cellular tissue forms a dome above the rim of the bowl; but when the retractor muscles invert the rostellum, it forces down this tissue of the scolex, and we then get that bowl, or crater-formation, which

gives such a beautiful appearance to the scolex, and which induced me—on the suggestion of Dr. Blanchard of Paris—to give it the specific name "Venusta." On total inversion the rostrum stands up, "like a candle in a lantern," and there appears on the sloping sides, half-way down the interior of the scolex, an annular formation. The transverse diameter of the scolex, when taken from the mucous membrane of the intestine of the duck, is 0·675 mm.; and its vertical length 0·405 mm. The length of the rostellum is, in my prepared specimens, 0·405 mm.; thus the inversion of the rostellum is, approximately, the vertical length of the scolex; and the depression being formed by the inversion of the rostellum, it follows that 0·405 mm. is the depth of the crater, or hollow of the bowl.

The Strobila.—The length of the strobila varies according to the age of the Tænia; the smallest of my collection of this species measuring $\frac{5}{8}$ in., and the longest $5\frac{1}{2}$ in. The former was a sexually immature specimen, being composed of 152 and the latter of 620 proglottides, and yet this was not a complete worm, it having already shed that portion of its strobila which had become mere uterine egg-sacs. The neck (Fig. 1*d*) is very short; in fact, segmentation commences so close behind the scolex, and the segments are so very incipient, that difficulty is experienced in accurately defining the exact distance from the scolex in which there are no segments; its length is not more than 0·200 mm. As the strobila continues its course the segments gradually enlarge both in length and breadth, but there is no perceptible change in their histology until the 218th proglottis is reached; and here we see the "Anlage," or commencing formation of the male organs—viz., the three testes. They are situated in close proximity to each other, and as yet there is no trace of vasa efferentia between them; their diameter at this stage is 0·050 mm., and the vertical length of the proglottis 0·090 mm., its width being 0·473 mm. On the dorso-anterior side, which is the porose side, near the proximal margin of the 240th proglottis, can be traced the "Anlage" of the cirrus, with its pouch; also at the margin the early muscular growth of the genital papillæ; and at the 280th segment the cirrus is mature, but the cirrus pouch has not assumed the ampulla form of the future vesicula seminalis superior. The testes, too, have undergone a great change: they are more globular, have increased their dimension to 0·070, and

the vasa efferentia can be traced between each of them and the cirrus; but there is no looping of the vas deferens, either on the exterior or within the interior of the pouch; and the pouch itself is still a slender muscular sac. The length of the proglottides at this stage has increased to 0·203 mm., and the width to 0·709 mm Within the last twenty segments the sinus genitalis with the vagina have made their appearance, and progressed in their development; although some fifty segments previously this had been anticipated, as it is at this point that the invagination of the cuticle of the segment takes place, and forms the rudimentary concavity of the future sinus genitalis; and this concavity is never effaced, but persistently remains in the older segments (Fig. 11*b*).

This in-pushing gradually continues, and thus the sinus is evolved from the parenchymatous tissue; but there is as yet no muscular thickening of the cuticle to form the genital papillæ until after the 300th segment is passed. Thirty segments farther on the proglottides are sexually mature or complete, minus the uterus. The testes have secreted their sperm, copulation has taken place, the receptaculum seminis is filled with spermatozoa, and the ovaries with their accessory glands occupy their normal positions in the segments. At the 450th segment the uterus is fully developed, and from the 563rd to the termination of the strobila, the proglottides are complete uterine sacs for the further development of the uterine eggs into the oncospheres or six-hooked brood.

The Genital Organs.

The genital organs consist of male and female.

The male organs are the testes, vas deferens, vesicula seminalis, the cirrus pouch, and cirrus.

The female organs comprise the vagina, receptaculum seminis, ovaries, yelk-gland, shell-gland, and uterus.

Each segment contains both sets of generative organs, and is self-fertilising. The genital pore, with its papilla, is uniformly unilateral. The male organs are always situated on the dorsal side; and the female organs, with the exception of the uterus, which is dorsi-ventral, are situated on the ventral side.

The Male Organs.—The testes are at first three globular bodies (Fig. 10, *a*, *a′*, *a″*), but when they ripen the proximal and distal

testes change to an oval form; the central one is situated in the posterior-median line, and is, from its "Anlage" up to its final disappearance, stationary. It is only in the young segments that their structure can be studied with any degree of accuracy. They are then seen to be composed of a number of pyriform glands (Fig. 2), which are filled with small globular nucleated cells, with their ducts directed towards the centre of the gonad. At the side of each gonad, where the efferent duct makes its exit, is a depression or cavity. The sperm secreted by the testes, in its initial stage as seen in sections, is a light grey flocculent substance, rolled up in coils. These minute coils are, on examination with a high power, seen to be immature spermatozoa; what change they undergo, either in the testes or in their passage along the ductus efferens to the vas deferens, I do not know; but the looped vas deferens within the cirrus pouch is always filled with mature spermatozoa, ready to be passed on by the cirrus into the vagina. The spermatozoon, as seen in the receptaculum, is a long thin filament with a diameter of 1μ. I have searched in vain to find the head of an individual. Even when the ovaries have exhausted themselves and, together with the yelk and shell-gland, have disappeared, the residue of the spermatozoa within the receptaculum still tenaciously remains, but both ultimately become absorbed in the tissue.

In ripe segments the oval proximal and distal testes measure 0·118 by 0·084 mm.; the diameter of the median testis is 0·135 mm. As I have remarked above, when the male organs develop these two testes separate themselves from the median one, and take up a position, the one nearer the proximal, and the other nearer the distal margin, or side of the proglottis. As they separate the vas efferens, Fig. 10, b, b', b'', elongates itself by cellular growth. Taking the distal testis, we find the duct springs from the farther side of the gonad, courses over it, hangs somewhat loosely, and then attaches itself to the efferent duct of the median testis; and in like manner to the efferent duct of the proximal testis. As it ascends to the cirrus pouch this duct becomes the vas deferens; and previous to entering the pouch, which it does on the ventral side, it forms itself into three loops (Fig. 10, c). It is only in young segments that this duct can be definitely traced, as in the ripe segments it is either obscured by the density of the tissue, or else by the developing uterus.

After its entry into the cirrus pouch it becomes a large, swollen, looped duct (Fig. 10, *c''*), filled with spermatozoa. The mouth of the vas deferens is attached to the root of the cirrus; it (the vas deferens) occupies the whole of the interior of the pouch, and thus the cirrus pouch becomes a vesicula seminalis.

The cirrus pouch, with its cirrus, occupies the anterior portion of the segment. It is an ampulla-like organ, with an elongated neck; in its early stage its position is horizontal. It runs laterally close under the overlapping of the segments, where they unite; but as the genital papilla develops it is drawn farther down, a depression is formed in the neck, and the orifice of the cirrus canal is turned upwards, nearly perpendicularly. It still maintains this latter position, although the pouch is sometimes carried farther down in an oblique manner, caused by the declension of the genital papilla. A third of the way up towards the proximal end of the pouch, attached to the longitudinal muscles, are the retractor muscles of the cirrus pouch; these branch off from the pouch and run some distance under the ventral side of the receptaculum, attaching themselves, or coalescing with the ring-like epithelial fold of the anterior boundary of the segment. In a transverse section these longitudinal muscles of the pouch are more or less exposed (Fig. 4, *e*); and they, like the whole of the muscular structure of these platyhelminths, are non-striated. At the narrow end of the neck of the pouch, the cuticle, together with the longitudinal muscles, turns inwards and forms a long narrow cirrus canal; the muscular structure in its inversion attaching itself to a chitinous ring, the mouth of the cirrus canal. They (the muscles) then descend in the form of an inverted cone, attaching themselves to the cirrus in the immediate neighbourhood—interiorly—of the exterior retractor, where they join the epithelial longitudinal muscles. This inverted cone of muscles is the elevator muscle of the cirrus. The length of the cirrus pouch is 0·380 mm.; the diameter of the pouch occupied by the vas deferens is 0·070; and the diameter of the orifice of the canal 0·034 mm.

The cirrus (Figs. 3, and 4, *c*), appears to be a long, narrow, flattened, pellucid rod; such, however, is not the case: it is cylindrical and opaque, with a diameter of 0·007—0·010 mm. Previous to copulation it terminates in a small hook. Its structure is composed, like the ring of the canal, of chitin. A transverse

section shows that the walls are very thick, and that the lumen is very narrow, being a trifle under 0·002 mm. in diameter. The root also terminates in a fine straight point whose aperture corresponds with that of the hook. When the tissue of the canal in the ripened segments has become absorbed, this so-called root of the cirrus is seen to be studded with small knobs, as if for the more secure attachment of the neck of the looped vas deferens. The cirrus itself is perfectly smooth, but the cirrus shield is studded some distance down with rows of spinous prickles (Fig. 3, *d*). Dr. Stiles, writing of Bertia Americana Leporis (Tapeworms of hares and rabbits—*Proceedings U.S. Nat. Mus. New York*, vol. xix., p. 168), thinks that these apparent rows of spines are "wrinkles of the cuticle," and caused by the retraction of the cirrus. I do not think so, at least in this case, because not only are they present when the cirrus is extruded, but they still exist in the uterine segment even after absorption of the cirrus itself, as in some segments undergoing absorption the cirrus has preceded the pouch. I have not been able to trace definitely any prostate glands, although at times I have fancied I could detect a faintly glandular structure at the distal neck of the canal.

The Female Organs.—When the genital organs are fully developed the genital papilla has become a stout, dense, muscular protuberance or boss, with a large orifice or cloaca. This papilla is composed of longitudinal and circular muscles (Figs. 7, 8, and 9); and a transverse section reveals the fact that these circular muscles, which are secondary to the longitudinal ones, divide the papilla into two distinct parts (Fig. 5, A—B*a*). One set of circular muscles surrounds the sinus genitalis, the other the distal portion of the cirrus pouch. This papilla contains the vaginal canal, which is *anterior* to the cirrus pouch, and is joined to the latter by the longitudinal muscular structure. The papilla is very flexible, consequently the orifice assumes various shapes; seen as an oval, which apparently is its natural condition, it is 0·169 mm. long by 0·102 mm. wide. The vagina, Fig. 10, *f*, lies comparatively deep down in the cloaca. The orifice of the canal is circular. The canal is composed of bundles of stout longitudinal muscles; these are distinct from the long muscles of the cuticle of the papilla, which in cross section give the vulva a stellate appearance (Fig. 6, *c*). During coitus these muscular bundles contract, and, in conjunction with the spines with which the canal is

furnished, clasp and retain the cirrus until the vesicula seminalis is emptied of its contents.

The vaginal canal runs downwards somewhat obliquely, then ascending it curves round and overlaps the cirrus pouch, and again descends to form a junction with the receptaculum seminis. The latter part of the canal is annulated, commencing where the canal overlaps the cirrus pouch, so that it can scarcely be considered a continuation of the vagina, but must be regarded as a ductus efferens. The duct is circular (Fig. 10, *g*), and in cross section its diameter is 0·013 mm.

The receptaculum seminis (Fig. 10, *h*) is a large pyriform sac, being 0·236 mm. long and 0·160 mm. wide. I consider it to be a swollen continuation of the ductus efferens of the vagina. Its situation in the proglottis never varies; it occupies the anterior median line of the segments close up to where they are connected, and is always overlapped by the posterior dorsal margin of the preceding segment. It is filled with spermatozoa before any sign of the uterus is visible in the segment, and is almost invariably the last organ to become absorbed in the uterine or ripe proglottis.

The ovary is a paired organ (Fig. 10, *l*, *m*). Its "Anlage" commences in the median line on the ventral side of the segment. As it progresses it gradually pushes its way backwards to the distal third of the segment; thus it lies laterally in the segment. It is not a fan-like structure, as in the Mammalian tæniæ, but consists of two lobes, each lobe being composed of a number of glands whose efferent ducts empty themselves into one common ovarian canal. The efferent ducts from each ovary (Fig. 10, *j*, *k*), previous to their forming a common duct, are inordinately long, the aporose duct being from its position the longest. Each lobe is encapsuled by a thin membrane. One lobe lies on the porose and the other on the aporose side of the proglottis. The former is composed of five glands, and is 0·270 mm. long and 0·101 mm. wide. It presses close up to the anterior margin of the segment. The aporose lobe contains six glands; it is 0·304 mm. long, and 0·135 mm. wide.

Immediately anterior to, and in the median line of the ovaries in the centre of the proglottis, is a comparatively small heart-shaped or triangular organ, the yelk-gland (Fig. 10, *n*). Its length from apex to base is 0·027 mm., width at base 0·017 mm.

It was filled in my specimen with apparently spherical cells, but so closely were they packed, and so freely had they taken the stain, that it was impossible, not only to define them, but also to trace the enveloping capsule. The shell gland (Fig. 10, *o*) is situated somewhat in front of, and contiguous to, the yelk gland It is an oval organ whose long diameter is 0·026 mm., and breadth 0·013 mm. Its capsular membrane is apparently, like the capsular membrane of the ovaries, structureless, taking no stain; while the cells, like those of the yelk gland, become so over-stained that it is impossible to define them.

As yet the generative organs of the Tæniæ of birds have been but imperfectly investigated, consequently we have not many data to guide us. Von Linstow, in his description of the anatomy of *Tænia depressa*, is silent, and makes no attempt in the sketch of the generative organs to give us an outline of the course taken by the ovarian ducts. It must not be thought I have overlooked the work of either Feuereisen (*Drep. fasciata*) or Schmidt (*Drep. anatina*). Unfortunately I am somewhat in the same situation as Von Linstow and others: I cannot give an accurate description of them. It is now, and always has been—even Leuckart found it so—one of the most difficult things to trace the course of these ducts, owing to the density of the parenchymatous tissue. Even in examining my sections cut from the segments, the ducts were found to be so severed and disconnected, that all attempts to trace and fit them together was an impossibility; consequently all one can do is somewhat problematic, and this is far from being satisfactory. But by putting together and fitting in different portions of these ducts as they appear in the sections, and taking one of the most perfect as a type, I have arrived at the conclusion that these ducts take the course as given in Fig. 10, *i*, *j*, and *k*. The fertilising canal from the receptaculum seminis is somewhat long. It crosses over the oviduct of the aporose ovary, which runs vertically across the segment, dorsally to the uterine canal, and makes a junction with the porose ovarian duct just below its descending loop, thus forming a single ovarian canal; the fertilising canal joining it just below the ovarian junction, thus forming one grand fertilising canal, and in which the small globular ova are fructified by the spermatozoa, and are conveyed into the shell gland, there to commingle with the albuminous substance poured into it by the efferent duct of the yelk gland, and by this

means the ova become fertilised, and are passed on into the uterus by the uterine canal.

The uterine canal (Fig. 10, *p*) springs directly from the shell gland, and runs transversely through the median dorsi-ventral line of the proglottis. As it approaches the proximal margin of the segment it slightly undulates, trending towards the anterior of the segment but afterwards continues its original course. It is a blind canal, having no exit pore, and its diameter is 0·020 mm. The uterus (Fig. 11) is a simple one—that is, the canal has no tubules; but the uterus is formed by the budding-off on either side of sacs, or pouches, for the reception of the fertilised eggs as they are passed on through the canal. These pouches ramify among the tissues, ranging themselves on either side of the segment, until it becomes a swollen uterine sac. Here the eggs mature and develop into the oncospheres or six-hooked brood, and like the ova of other Tæniæ whose uterus is destitute of a pore, they have to await the desiccation of the proglottis or the ingestion of it by an invertebrate, before being set free.

The mature eggs have no appendages. They have two membranes, an outer covering or shell (?) and a secondary or vitelline membrane. The clear space between the shell and the second membrane contains a quantity of fat globules. As development progresses these fat globules are absorbed, and one of two things occurs in connexion with this secondary membrane: either it becomes absorbed, or it adheres to and forms an endothelial lining to the shell. If the latter, it remains so, for in the latter stages of development the embryo lies perfectly naked within the egg. It is not my purpose to discuss the successive stages in the metamorphosis of the embryo from the morula stage to the development of the oncosphere, as these have been almost exhaustively dealt with by Van Beneden and Moniez in connexion with the ova of mammalian Cestodes; but I must make a few observations on a stage in the development of the embryos of *Drep. venusta.* Rudolf Leuckart tersely says: "The young Cestode embryos have not the least resemblance to the adult form; they are microscopic balls with six apical hooks, and differ widely from the tapeworm both in shape and size. Between these two extremes we find a long series of wonderful metamorphoses." I have, in a previous communication, explained that portion of the development of this Tænia by which the cysticercus

evolves itself into a perfect tapeworm. This paragraph of Leuckart's exactly expresses what I should myself have written as to the stage these Cestode ova attained, previous to their being swallowed by a crustacean to become in its body cavity "a cysticercus." But the uterine egg of *Drep. venusta* (Figs. 12, 13, 14, 15 and 16), that is to say the six-hooked brood, passes from the usual microscopic ball through successive stages, until it arrives at a stage which reminds one very forcibly of that of the encysted larval stage of *Dibothridæ*, such as the Bothriocephalus larvæ found in the smelt or, when straightened out, to a young bladder-worm of *Tænia serrata* or *Cysticercus pisiformis* found in the liver of the rabbit. Indeed, the uterine embryos in the ripened segments of the latter Tænia are so far advanced in development that there is seemingly but a stage between it and what the young bladder-worm will be as a *Cysticercus pisiformis.* I have never traced the larval form in the ovum, as one finds it in the hydatid; but this I do know, that this elongation or pyriform state does not take place until after the ova of *Tænia serrata* has been swallowed by the rabbit. In like manner up to the present time I have never seen the ova of avian cestodes change to a form so similar to that which we find in the later stages of the cysticercus of *Drep. gracilis*, minus the hooks and suckers, as these uterine embryos of *Drep. venusta.* I would more particularly call attention to the development seen in Figs. 14, 15, 16, to illustrate the above remarks. I have no wish to beg the question, but the inferences one feels tempted to draw from this advanced stage in the metamorphosis of the ova of *Drep. venusta*, before it enters the body cavity of the Cypris to become a cysticercus, are not, from observations made by me up to the present time, sufficiently matured for me to draw any parallel, or express an opinion as to their differentiation. Morphologically it is sufficient to serve as a note, or reference, in any future researches that may be made in connexion with the development of the ova of the Tæniadæ. The oncosphere is oval, its length, including the capsule, is 0·047 mm., breadth 0·030 mm. The embryo (Figs. 15, 16) is approximately 0·034 mm. in length, breadth 0·020 mm. The six hooks of the oncosphere (Fig. 17) measure individually 0·009 mm., *a—b*, 0·006 mm., *a—c*, 0·009 mm.

The calcareous corpuscles are scarce in young segments, but when the segment becomes gravid they range themselves very

thickly on each margin of the proglottis. Some are oval whilst others are circular with concentric lamellæ; seen in sections they measure, the former 0·010 mm. by 0·013 mm., the latter have a diameter of 0·010 mm.

When the looped vas deferens within the vesicula seminalis has been filled with spermatozoa, then, and then only, does copulation take place. During the secretion of the spermatozoa the cirrus has remained within the sheath below the annular orifice. This filling of the vas deferens has the effect of pressing it, owing to its swollen condition, closely against the walls of the pouch, which causes the circular and longitudinal muscles of the pouch, and the proximal retractor muscles, which are attached to them, to stretch to their utmost. When the vas deferens is filled to repletion they suddenly contract, and this sudden contraction of the proximal retractor muscles shortens the pouch, forces out the cirrus in an upward, though somewhat curved direction, dragging with it the neck of the vas deferens, and consequently the vas deferens as well, for the looped vas deferens is perfectly free within, and independent of the pouch; and at times when fully exserted a portion of the sheath is extruded with the cirrus. Once above the cloacal orifice, the cirrus bends downwards and inserts itself into the vaginal orifice. This sudden contraction of the muscles of the pouch, pressing against the distended vas deferens, forces up the sperm, causing it to run up the cirrus and enter the vaginal canal. It then runs down the annulated efferent duct, and fills the receptaculum, where it is stored up for the fertilisation of the ova. When the vas deferens is emptied of its contents the act of coitus is complete, and the cirrus withdraws itself, by the retraction of the elevator muscles from the vagina, back again into the sheath. Von Linstow thinks that "once the act of copulation has taken place, the cirrus does not return again into its sheath"; such, however, is not my experience with *Drep. venusta*, excepting when the sheath has been extruded with the cirrus. I find in those ripe segments which were ready to separate themselves from being an integral part of the strobila—and it is on these segments I have made my observations respecting the development of the ova—that, when all the other male organs have become absorbed, the chitinous cirrus is not extruded, but is drawn completely back into what remains of the sheath. So far as it applies to *Drep. venusta*, one

act, and one act only, of coitus, ever takes place. When the cirrus is extruded from the vaginal canal it is seen in every instance to be denuded of the hooked termination, broken off no doubt by the rows of inverted spines which line the interior of the vaginal canal. Their utility is to secure the cirrus from being drawn back by the retraction of the elevator muscles during the flow of the sperm or emptying of the vas deferens. The act is somewhat slow, as the cirrus aperture is small. Once the looped vas deferens in the vesicula seminalis is emptied, it is never refilled by the testes.

Explanation of Plates 1 and 2.

Fig. 1. Scolex of *Drepanidotænia venusta*. Fresh specimen taken from the mucous membrane of the intestine of a duck. *a*, suckers; *b*, rostellum inverted; *c*, ring formation caused by inversion of rostellum; *d*, neck. × 21.

Fig. 2. Young testes, to show pyriform glands in interior. Each circle of glands is composed of an uneven number, the central number being nine. I have not figured the two primary layers of three and one. × 210.

Fig. 3. Vesicula seminalis, with cirrus previous to coitus. In the interior of the pouch is the looped vas deferens, *a*, filled with spermatozoa; *b*, attachment of vas deferens to root of cirrus, *c*; *d*, spines in interior of canal; *e*, annular orifice of canal. × 210.

Fig. 4. Cirrus pouch in oblique section; *c*, cirrus after coitus, with loss of terminal hook; *e*, longitudinal muscles; *f*, ductus efferens of vagina in cross section. × 210.

Fig. 5. Vertical section through anterior portion of papilla. *A*, cirrus and portion of canal; *a*, circular muscles surrounding neck of pouch; *b*, longitudinal muscles of papillæ in section. *B*, vagina; *a*, circular muscles; *c*, vaginal canal; *b*, longitudinal muscles of same. × 210.

Fig. 6. Flattened cloaca of papilla, as seen in prepared segment. *a*, cirrus after coitus; *b*, orifice of canal; *c*, vagina; *c′*, vaginal opening of canal. × 210.

Figs. 7 and 8. Two genital papillæ. 7, cirrus within pouch, previous to coitus; 8, cirrus partially protruded and entering the cloaca. × 93.

FIG. 9. Transverse section of papilla previous to coitus, showing cirrus more fully everted than in the previous figure; also vaginal orifice and longitudinal muscles of vaginal canal. × 93.

FIG. 10. Male and female genital organs *in situ*. *a a′ a″*, testes; *b b′ b″*, vasa efferentia of same; *c*, looped vas deferens, *c″*, looped vas deferens, interior of pouch, containing spermatozoa; *d*, vesicula seminalis, or "cirrus pouch"; *e*, cirrus with vas deferens attached to its root; *e′*, orifice of cirrus canal; *f*, vagina with canal; *g*, ductus efferens of same; *h*, receptaculum seminis filled with spermatozoa; *i*, fertilising canal making a junction with porose oviduct; *j*, porose oviduct; *k*, aporose oviduct forming a junction with *j*; *l*, porose ovary; *m*, aporose ovary; *n*, yelk gland with its efferent duct; *o*, shell gland; *p*, uterine canal. The ovaries, yelk gland and shell gland should be nearer the receptaculum; they have been figured thus, although drawn to scale, to show the probable course of the fertilising canal and oviducts. × 62.

FIG. 11. Ripening segment, dorsal. *a*, uterine pouches containing ova; *b*, vaginal opening on proximal margin; *c*, distal margin; *d*, anterior margin; *e*, posterior margin of segment × 70.

FIGS. 12, 13, 14, 15, 16, successive stages in the development of the oncosphere. × 350.

FIG. 17. One of the six hooks of the oncosphere, × 1400.

Notes on Some Little-Known Species of Pterodina.

By Charles F. Rousselet, F.R.M.S.

(*Read January* 21*st*, 1898.)

Plates 3, 4, 5.

The interesting group of oval or nearly circular and flat Rotifers of which *Pterodina patina* is the type, has always been admired by microscopists on account of its peculiar beauty, the glassy carapace, when reflecting the light under a good dark ground illumination, resembling a bright new silver coin more than anything else. Pastor Eichhorn was perhaps the first to discover, figure and describe a member of this group, in 1781, followed soon after, in 1786, by O. F. Müller, who speaks of it as "Animalculum crystallinum splendore nulli secundum," and so it is to-day.

Seven species have been mentioned by Dr. Hudson in his great work, but since then six or seven more species have been added to the list, making thirteen or fourteen species in all that are now known, as follows :—

Pterodina patina Ehrbg.
,, valvata Hud.
,, clypeata Ehrbg.
,, elliptica ,,
,, mucronata Gosse.
,, reflexa Gosse.
,, truncata ,,
,, parva Ternetz.
,, incisa ,,
Pterodina bidentata Ternetz (= Pt. emarginata Wierz).
Pterodina cœca Parsons.
,, trilobata Shephard.
,, intermedia Anderson.
,, crassa Levander (= Pt. clypeata).

It is not the object of this paper to pass in review all these species, but only to describe four or five of them which have come under my observation, and which, owing to insufficient figures, are somewhat difficult of identification.

One of the principal characters of the genus, as defined by

Dr. Hudson, reads as follows: "lorica entire, greatly depressed, of two oval or nearly circular plates soldered together at their edges." This last character will have to be modified, as quite a number of the species, though generally depressed, have a lorica of considerable thickness and rounded at the edges, thus giving much more room for the internal organs, and consisting of stiffened integument not separable into two plates, but obviously continuous all round. It is my opinion that even in the very flat *Pt. patina* there are not really two plates soldered at the edges, but that it has only this appearance, and that in reality the lorica is continuous all round, but closely appressed at the periphery.

I may here also record my belief that *Pt. valvata* is only the young form of *Pt. patina*. When young the integument is yet soft and flexible, and the strong retractor muscles of the head being fixed near the edge of the lorica on each side, fold down the sides like flaps when contraction takes place. I have seen this form repeatedly, always in company with *Pt. patina*, from which it can otherwise scarcely be distinguished.

Pterodina reflexa (Plate 4, Fig. 5). I have met with much difficulty in identifying this species from Mr. Gosse's scanty description and peculiar figure, but was able to do so after seeing some of Mr. Gosse's original drawings, which have not been published. I received this small animal from Mr. John Hood, of Dundee, in January 1896. From a purely dorsal or ventral view, and with a monocular microscope, the peculiar shape of the lorica can hardly be seen; and it is necessary to observe the animal in the act of swimming, turning round and over many times under the binocular, in order to realise all its peculiarities. The shape of the carapace is oval, obscurely pointed posteriorly, the two sides curved upwards like an open **V** at an angle of about 130°, and with thickened and rounded edges, as will best be seen by the transverse section, fig. 5*c*. The anterior frontal margin is raised, and has a very slight depression in the middle, while the mental edge has a very deep and square sulcus.

The foot opening is situated near the posterior margin of the lorica, and is oval in shape. The lateral antennæ are seen protruding about the middle of the lorica, close to the edge. Mr. Ternetz's new species *Pt. incisa* appears to have considerable

resemblance with *reflexa*, but if correctly described it can be distinguished by the following characters: *Pt. incisa* has the sides still more turned upwards, forming an angle of nearly 90°, and the margin is thin according to Ternetz's drawings, which I have reproduced in Fig. 8 *a* and *b*, and not rounded and thick; further, the dorsal anterior edge has a deep rounded sulcus as well as the mental edge, and the lateral antennæ are situated more anteriorly.

The internal anatomy of *Pt. reflexa* is normal and well represented in Mr. Dixon-Nuttall's drawing, Fig. 5*a*.

Size: length of lorica $\frac{1}{170}$ in. (150 μ), width $\frac{1}{260}$ in. (98 μ).

Pt. elliptica Ehrbg. Plate 4, Fig. 4. This species has never been well defined by Ehrenberg, and is scarcely differentiated in Hudson & Gosse's monograph, where it is represented only by the doubtful figure of an empty lorica. It is, however, a well characterised species, which I have often found living a parasitic or rather commensal life on the legs and gill plates of *Asellus vulgaris*. It is the largest of the various species with thickened edges. The lorica has the form of a long oval with somewhat flattened anterior dorsal margin; the mental edge has the form of two semicircular lobes, with a deep acute sinus between them, as seen in Fig. 4*b*. The shell has considerable thickness, and its exact shape will best be understood by reference to the transverse section, Fig. 4*d*; the edges are thick and rounded all round, increasing in thickness posteriorly; the dorsal surface as a whole is slightly convex, with two depressions between the rounded edges and the higher central region; the ventral surface has the central part projecting with a longitudinal shallow groove on each side.

The foot opening is close to the posterior edge on the ventral side, and half-moon-shaped. The lateral antennæ are high up on the shoulders, and the very small dorsal antenna, not before discovered, was found, situated in the middle line just above the mastax when the animal is fully extended; it is found in the same position in all species of Pterodina. Two large elongated gastric glands are conspicuous in this species; fixed to the anterior part of the stomach, they lie at right angles across the body on each side, and appear to be attached near the edges of the lorica. A second pair of smaller gastric glands are situated just above the others, and show a number of large nuclei. The

lateral canals lie close to the intestine, and flame cells were seen along their course. The stomach and intestine were seen to be filled mostly with diatoms.

Size: length of lorica $\frac{1}{125}$ in. (204 μ), width $\frac{1}{185}$ in. (136 μ).

The Male. Mr. Dixon-Nuttall has found the male of this species, the first male *Pterodina* ever seen; it is shown in Fig. 4, *e* and *f*. In outline it is very narrow, elongated, and quite unlike the female. It has a decided, but rather soft, lorica, and two red eyes in front, but is devoid of jaws. The copulatory organ projects dorsally above the foot, which is of usual structure and ciliated at the end. Size about $\frac{1}{200}$ in. (127 μ).

In a private letter Mr. Bilfinger states that he has observed the male of *Pt. patina*, which agrees with that of *Pt. elliptica* in every particular.

Pt. clypeata (Plate 3, Fig. 2). This is a very old species, first seen in the second half of last century (1786) in sea-water of the Baltic by O. F. Müller, and afterwards described by Ehrenberg, who appears to have observed the thick rounded edges of the lorica, but thought the edges were merely curled round. Mr. Gosse's figure in the Rotifera (Plate XXVI., Fig. 14) is scarcely accurate; it is represented too square and too angular posteriorly, and as being flat. I have obtained this animal from Mr. John Hood, who, I believe, finds it occasionally in brackish tide pools of the estuary of the Tay; and from these the accompanying figures have been drawn, partly by Mr. Dixon-Nuttall and partly by myself.

The lorica is a long oval with a squarish look about it, which is well expressed in the figure. It is of considerable thickness, convex dorsally, and has thick rounded edges with a smaller convex ventral side, as will best be understood by the transverse section, Fig. 2*c*. The anterior dorsal edge of the lorica is a smooth rounded line, the mental edge is slightly wavy with a fairly deep semicircular sulcus in the middle. The foot opening looks like a mere slit in the ventral plate at some little distance from the posterior edge. The lateral antennæ are situated at the sides, a little above the middle. Eyes of usual shape are present, and the anatomy otherwise is normal; Fig. 2*d* is Mr. Nuttall's drawing of the jaws.

Size: length of lorica $\frac{1}{170}$ in. (150 μ), width $\frac{1}{250}$ in. (102 μ).

Pt. cæca (Plate 3, Fig. 1). This is another species found

living commensally on *Asellus vulgaris*, and was first described by Mr. F. A. Parsons in our JOURNAL of January 1892, but only figured by a small outline drawing of the lorica. The accompanying figures will, I hope, give a better and more accurate idea of this small but interesting species. The lorica is egg-shaped, truncate in front, the anterior dorsal edge prolonged into a rounded cone, the mental edge is incised with a not very deep acute sinus. The shell is thick, and has thick rounded edges, which are slightly curved upwards; the ventral side shows two shallow depressions and the dorsal side two deeper ones, and the whole shape of the lorica will best be understood by referring to the transverse section, Fig. 1*d*.

The foot opening is situated quite close to the posterior ventral edge; it is broad and shield-shaped. The lateral antennæ are very minute, but can be seen projecting near the edge of the lorica a little above the middle; the dorsal antenna was found situated slightly higher on the middle line, above the mastax when the animal is extended. The gastric glands are large, and broaden out towards the edge, otherwise the internal anatomy is normal. A great peculiarity of this species is that it has no trace of eyes which are so prominent in all other species. *Pt. Cœca* has been obtained mostly from Epping Forest. Fig. 1*e* represents the jaws, drawn by Mr. Dixon Nuttall.

Size of lorica: $\frac{1}{150}$ in. (170 μ) by $\frac{1}{235}$ in. (108 μ) broad.

There is yet another species which habitually takes up its quarters on *Asellus*—namely *Pt. truncata* (Gosse), mentioned by Mr. G. Western in our JOURNAL for July 1893, p. 155, and figured in outline on Pl. XXV., Fig. 4 (QUEKETT JOURNAL, January 1892). The animal figured by Dr. W. Barnett-Burn under the same name in *Science Gossip*, 1889, p. 104, is, I believe, *Pt. elliptica*. Mr. Western maintains that *Pt. truncata* is a distinct species; it is certainly very closely allied to *Pt. elliptica*, if it is not identical with it.

In 1892 Dr. Ternetz described a new species, *Pt. bidentata*, which has lately also been found in England by Mr. John Hood and Mr. Dixon-Nuttall. It has a flat and nearly circular lorica, but is remarkable in having a large thorn on each side of the latero-posterior margin. In 1893 Prof. Wierzejski described the same species under the name of *Pt. emarginata*, and it has also been observed by Forstmeister Bilfinger in Württemberg. The

figure here given, Pl. 5, Fig. 6, has been drawn by Mr. Dixon-Nuttall from life.

In order to facilitate reference to the other known species I reproduce on Plate 5 some figures of the following :—*Pt. parva* Ternetz, *Pt. incisa* Ternetz, *Pt. intermedia* Anderson, and *Pt. trilobata* Shephard. *Pt. crassa*, of Levander, found in brackish sea-water on the coast of Finland, I consider to be almost certainly identical with *Pt. clypeata*, as an inspection of Dr. Levander's figure will show. *Pt. intermedia* and *trilobata* appear to me to be only slight variations of *Pt. patina*. I have not, however, seen any of these species, and must refer for their description and further particulars to the original papers given below.

I may add here that, although it is stated in the monograph that the contractile vesicle appears absent, it has been seen in all species examined. It is small, and requires to be carefully looked for, and often a slight pressure under the compressor is required to make it out clearly.

The following are the papers referred to above :—

Anderson, H. H. "Notes on Indian Rotifers." *Journ. Asiatic So. of Bengal*, 1892. 3 Pl.

Levander, K. M. "Wasserfauna in der Umgebung von Helsingfors. II. Rotatoria." *Acta Societatis pro Fauna et Flora fennica*, XII., 1894. 3 Pl.

Shephard, J. "Notes on Victorian Rotifers." *Proceedings of Royal Society of Victoria*, 1892. 2 Pl.

Ternetz, C. "Rotatorien der Umgebung Basels," 1892. 2 Pl.

Wierzejski, Prof. A. "Rotatoria Galicyi," 1893. 4 Pl.

I trust these notes and figures will assist in the identification of the various species mentioned, and will remove the doubt and confusion which previously existed.

Explanation of Plates 3, 4 and 5.

Fig. 1*a*. *Pterodina cæca*, dorsal view. Size of lorica: length, $\frac{1}{150}$ in. (170 μ); width, $\frac{1}{235}$ in. (108 μ).

,, 1*b*. ,, ,, ventral view of lorica.

,, 1*c*. ,, ,, side ,, ,,

,, 1*d*. ,, ,, transverse section of lorica.

,, 1*e*. ,, ,, the jaws.

FIG. 2*a*. *Pterodina clypeata*, dorsal view. Size of lorica: length, $\frac{1}{170}$ in. (150 μ); width, $\frac{1}{250}$ in. (102 μ).
" 2*b*. " " ventral view of lorica.
" 2*c*. " " transverse section of lorica.
" 2*d*. " " the jaws.
" 3. " *intermedia*. Mr. Anderson's figure. Size of lorica: length, $\frac{1}{120}$ in. (212 μ).
" 4*a*. " *elliptica*, dorsal view. Size of lorica: length, $\frac{1}{125}$ in. (204 μ); width, $\frac{1}{185}$ in. (136 μ).
" 4*b*. " " ventral view.
" 4*c*. " " side view of lorica.
" 4*d*. " " transverse section.
" 4*e*. " " male, side view.
" 4*f*. " " " ventral view.
" 5*a*. " *reflexa*, dorsal view. Size of lorica: length, $\frac{1}{170}$ in. (150 μ); width, $\frac{1}{260}$ in. (98 μ).
" 5*b*. " " ventral view of lorica.
" 5*c*. " " transverse section.
" 6. " *bidentata*.
" 7. " *parva*. Mr. Ternetz's figure.
" 8*a*. " *incisa*. " " "
" 8*b*. " " transverse section. Mr. Ternetz's figure.
" 9. " *trilobata*. Mr. Shephard's figure.

Of the above figures 1*a* and *e*, 2*a*, *b*, *d*, 4*a*, *b*, *e*, *f*, 5*a* and 6, have been drawn from life by Mr. F. R. Dixon-Nuttall in his usual excellent style; figs. 3, 7, 8 and 9 are copied from Messrs. Anderson's, Ternetz's, and Shephard's published drawings; and I am responsible for the remainder.

THE PRESIDENT'S ADDRESS.

By J. G. Waller, F.S.A.

Delivered February 18th, 1898.

Another year has passed away, and I again stand before you to perform a duty which my office demands of me, but which I am about to resign unto another. There is an old Latin adage which says, "Time brings roses"; we also know of another, that "Roses have thorns." But my time with the Club, in the last year as in the previous one, has brought me the roses without the thorns. This remembrance enforces upon me that which I owe you all for your courtesy, and to the merits of the officers by whom the Club is so well served and represented. When all are so good, it would be almost invidious to specialise; but every one knows how important it is to have a good Secretary and Treasurer; and here we may well congratulate ourselves, for with an experience of over half a century in the management of societies, I know how much success is due to those entrusted with the guidance.

But if I might use the metaphor of the roses further, I should find it in the action of the Club itself, which has gone on smoothly developing during the past year. I never come down to the meetings (and I am rarely absent) without finding both interest and instruction; and when I look back upon the past, I am struck with the great superiority in the character of the objects exhibited, and also in the mode of exhibition.

When we speak of science in the abstract, it is as one. But it has numerous subdivisions, which, however, bear upon one another, assisting each other; for in the brevity of human life, one person can never be accomplished in all. And this subdivision seems to be on the increase—indeed, necessarily so; but in the end it must lead to a more comprehensive and general knowledge. Societies are composed of various units, each of whom may add to the general sum of knowledge, though all may be moving in divergent directions; but these very divergencies may have an ultimate tendency to reunion. However humble may be the

effort or the observation, if it be honestly recorded, it is of value, although the conclusion arrived at may be inaccurate, for it is nevertheless on the road to truth. We often by "indirections find directions out." But in all inquiries let us avoid dogmatism. Sitting *in cathedrâ* may be very agreeable to our self-love, but there is the constant danger of being tumbled from our stool. Nevertheless, it is well to be firm in our convictions, should they have been diligently arrived at; yet to be ready to give them up when found to be untenable, for this is the true philosophy of science. It is here that lies the advantage of constant association with those studying in like directions, tending, as it does, to that beneficial condition of the mind. Thus it is, that the practice of exhibiting a series of objects illustrative of a special class of organisms is greatly to be commended, as well as drawings executed under the microscope, as it assists more than any other way the general knowledge of natural history. Time was, when books were few, as well as those capable of reading them, that pictures were resorted to as teachers; and the people's book, or, as it was called, "The Book of the Ignorant," was written in art, making appeals to the senses, and thus to reach the mind. Nor have we set aside, in our progress, this ready means of teaching; for art, now combining with optical science, is more called upon than ever, as no description can come up to actual representation. In the work of the microscope, therefore, it is most essential to have such record. It is here also especially necessary to study the interpretation of the magnification by high powers, lest the eye should be deceived in the character of that presented before it—a subject that has been well considered by members of the Quekett Club.

In all matters of scientific inquiry, there is an especial pleasure in taking up a subject at its beginning and working it out to a result. It leads us on often into "fresh fields and pastures new." When we commence, it is probably only to verify or convince ourselves on previous observations, and we may be rewarded in discovering more than we expected. This has been my personal experience on more than one occasion, and it must be of frequent occurrence in microscopical study. For the field of nature is boundless, and we may often find what we have called "common objects" appear in a new light by our extended vision.

These remarks have suggested themselves to me on my recollec-

tion of taking up the subject of "sand," when I had no idea that the scope of my inquiry would lead me very far. But, instead of that, I found that the more I advanced, the wider became my view, and sciences that I had but little studied had to be called in to my aid. The ubiquity of quartz in the composition of this globe was but a step in comparison with that which the study might unfold; and when I thought I might come to a conclusion, it only seemed a first step preliminary to further researches. But this is one of the charms attendant upon microscopical studies. I had noted occasional instances of crystallised forms of geometrical accuracy in the quartz particles, and had laid this subject down for future consideration, when I was diverted into an entirely new walk. This arose from my having obtained from the Trinity House samples of sand from the lightships, chiefly in the German Ocean, immediately off our coasts; and this led me into one of the most interesting subjects in which I was ever engaged by the microscope, opening up an entirely new field. We are all aware what a large and important family are comprised under the name of Fungi. They are everywhere performing work; perhaps, in many cases, they may be included under what Linnæus called "servi," those who go before to prepare the way. But often the slave becomes the master, and a potent destroyer. Every housewife knows of the mould that occasionally appears on her preserves. But these apparently simple forms are ever ready to develop as ministers of evil. The potato disease, and that of the vine, which some years ago caused such havoc, was due to fungi; and many other forms of vegetation are equally attacked. Perhaps the greatest culmination of evil is in the terrible fungus foot of India. But many a house has been brought to ruin by this subtle destroyer. Yet one would scarcely have expected to find that fungi, or their allies, were to be found excavating into small particles of calcareous sand, and belonging to genera that may be classed amongst the "moulds," and at two fathoms depth. But, strange to say, though it was a novelty to be thus discovered, and had never before been found in such a variety of forms, yet such operations were not new in the world's history nor in the records of science. In fact, the late Professor P. M. Duncan had found similar in deposits as far back as the Silurian age—a period so illimitable that the mind shrinks from any attempt to compute the myriads

of ages that have passed since the deposit alluded to was made. So, here, we are face to face with an eternal law still operating in our own seas, as in days gone by, manifested in the story of the Gabbard and Galloper sands.

One cannot, however, do otherwise than note, that some uncertainty exists as to the class to which the organisms above referred to should be placed—viz., whether Algæ or Fungi. Long ago Fries, a Swedish botanist, was of opinion that Algæ, Fungi, and Lichens have so close a relation to each other as to be interchangeable, and Dr. Lindley expressed the same views. When developed in water they were Algæ, the same on land or in air Fungi or Lichens. That there are close analogies may be undoubted, but, one might ask, whether the rest is not a matter for experiment. Otherwise it must be regarded only as an hypothesis. Kölliker was of opinion that the organisms alluded to must be referred to the Fungi; it was to this class I turned in my study of them, and here that I found most analogies in form and character. This was also the opinion of Dr. M. C. Cooke, who presided when I read my paper, and who has rendered such eminent services on the subject of Fungi, and of the microscopic Algæ, and he referred them to the "Moulds."

But if we may entertain the possibility of evolution or devolution in the classes above named, how much more necessary is it to consider the propriety of not too readily making species in lower organisms, where changes must be frequent and constantly taking place according to the habitat! That this practice of creating species has too often taken place in the class alluded to, has received criticism from one who has done such excellent service in its study, the Rev. M. J. Berkeley, who, in an article on the Fungus foot of India, says: "Mere mycelia have been described as perfect plants, mistakes have been made in important points of structure, and productions of an undoubted fungoid nature been referred to Algæ, though agreeing with them neither in habit nor physiology, while the commonest Moulds have received new names, and several conditions of the same species have been registered as autonomous productions." I cannot but feel that the character of this criticism might be even more widely applied.

It was due to Dr. M. C. Cooke, our then President in 1884, that I was directed to the subject of the Fungus foot, of which

there is a good account in the "Intellectual Observer," Vol. 2, by the eminent writer above named. By which it appears, that this terrible disease attacks the bones of the lower extremities, and the victim dies of exhaustion. The fungoid species in question has been placed with the Mucors or Moulds, and, in the article referred to, is an illustration of it by the late Dr. H. J. Carter, F.R.S.; and I was particularly struck by the close resemblance it has in character with an illustration of mine in one of the objects from the Varne Sand, to which I gave the provisional name of *Saprolegnia Varniensis.* The analogy is remarkable as seen in the mycelia, as also in what appears to be the development of sporangia (*vide* Pl. XV., Figs. 3, 4, Vol. 1, Ser. II., of our JOURNAL.) It agrees with my argument on the nature of evolution, arising from differences of conditions; and the large family of Mucors may be set down as potent destroyers closely allied to each other.

I have alluded to what is constant and continuous in nature's law, which may now bring us to consider changes to which we must equally have our attention directed. Every naturalist must at times take note of the disappearance of organisms where they formerly abounded. The variations of the seasons, a succession of droughts, or a succession of wet with storms, necessarily affect the conditions of life. Then we have to take into account the neighbourhood and increase of large towns, and physical changes inevitable from drainage. The latter will especially affect the hunting grounds of the microscopist, and it is felt at Hampstead Heath and other suburban resorts. But I have often found changes where there were no altered conditions, at least apparent, especially as regards the Diatomaceæ, and of course it would be equally seen in other organisms of a like kind or lower type. We do not know the law thus operating, but can easily understand that physical conditions are answerable for most of the changes observable. But if the extension of our towns is inimical to some animal or vegetable natures, it may be favourable to others. It is not every plant that dislikes the excess of carbon, and there may be some of the minute organisms on the animal side equally agreeable to it.

In the neighbourhood of London, indeed throughout its geological basin, earth thrown up from an excavation is immediately productive of the well-known plant the colt's-foot; and

John Ray records that after the great fire of London, in 1666, the ruins were covered with a special plant, the conditions being probably favourable for its production. He calls it *Erysimum latifolium*, smoother broad-leaved hedge mustard, and speaks of it as growing "circa Londinum in variis locis," as "between the City and Kensington in great plenty, also about Chelsey. After the great fire of London, in the years 1667—1668, it came up abundantly amongst the rubbish in the ruins." The old herbalists describe it as growing in by-ways and in untoiled stony places, so that in the ruins it found a congenial soil. The plant is identical with *Sisymbrium Iris* (Linnæus), London Rocket. Other writers have alluded to the phenomena in a somewhat exaggerated language, stating "that it had been calculated that the whole of the rest of Europe could not contain so many plants of it." Statements like these have but little scientific value in themselves, yet they necessarily declare a remarkable circumstance that could have called forth such an utterance. The general subject is a very large one, and has been well treated by many able writers, from White of Selborne down to our own time.

Whatever change takes place in the vegetable world must have its complement in the animal kingdom, as there is a mutual dependence in some form one upon the other. We may assume that this takes place in minute structure, though perhaps less easily discoverable even with the aid of the microscope. But where such are obvious and well recorded it must add another passage to the history of life.

But, in this eventful history, we are every now and then being admonished of our ignorance by a new discovery. In the records of the British Association of the past year there was a curious account of the development of the Eel, of which, as it bears a little on my subject, I may be permitted to give you an abstract. Although such a familiar creature, a fish with a somewhat reptilian form, it is singularly remarkable, that the story of its life development has been buried in obscurity until our own time. This, however, is easily understood when we know the circumstances and the extreme difficulty in arriving at the information required. As a rule the salt-water fish enters our rivers to spawn, but with the Eel this is reversed, as it goes to the deep sea in the autumn or early winter to the depth of about two hundred and fifty fathoms to lay its eggs. Here it undergoes a change.

Eyes enlarge and become circular instead of elliptical, pectoral fins and border of gill-cover turn black; reproductive organs only discoverable by the microscope enlarge; eggs rather large for fish (12·7 mm. diam.) float, but do not rise. The young which issue are quite unlike the eel of our rivers. They are tape-like, transparent, colourless, devoid of red blood, armed with peculiar teeth, and known to naturalists as *leptocephali*. When one has completed its first stage of growth it ceases to feed, loses bulk, and develops pigment on the surface of the body; the larval teeth are cast, and larval skeleton replaced; then it begins to feed again, comes to the surface, enters the mouth of rivers, and, if caught, is recognised as a young eel, and is now a year old and two inches long. You may imagine, of course, that it could only be under very favourable circumstances and situation that such an interesting disclosure could be made; and this was due mostly to Signor Grassi, an Italian, and it gives us a hint how much more there is yet to learn even of familiar objects.

But it is not everybody that can extend researches to a depth of two hundred and fifty fathoms, and there is plenty of work to be done on our shores by those prepared for it. I think it is to be regretted that the Marine Algæ have not more students amongst us, for in this we miss our late friend Mr. Buffham; the Spo ges also, which are often found in abundance, and are ever ready for those prepared for their study, have too few students amongst us.

Before I bid farewell to the chair in which you have done me the honour to place me, I consider it will be well if I go back to a controversy I maintained, and on a subject on which I have now an altered opinion. It is proverbial that "confession is good for the soul." In all my studies I have avoided an unsupported hypothesis, and have ever endeavoured to give evidence for what I have advanced. I have also acted on the principle of the text "Whatsoever thy hand findeth to do, do it with thy might," for by this you are being just to yourself, and if you are in error, and it is proved upon you, or you have convinced yourself, it becomes your duty as an investigator of truth to avow it, and to give the reasons for your change of opinion. This is then my position, and the question is that of the Clionæ or Boring Sponges.

When I entered into this subject, after reading Mr. Hancock's paper, and the argument of Dr. Bowerbank, vol. ii., p. 212,

under the head of *Hymeniacidon Celata* of British Spongiadæ, I felt that the strength of the evidence rested with the latter, who considered that the excavations in oyster shells were due to annelids, and the sponge developed afterwards. Dr. Bowerbank's description is full of interest, but it is too long, and unnecessary here to be given: my reference is sufficient, and my purpose is to show the reasons for my change of opinion. Being frequently engaged at Torquay, I used my leisure and recreation in researches on the shore. At Anstey's Cove I picked up a fragment of oyster shell having the excavations referred to, but entirely denuded of sponge, and here I found the remains of annelids, or it may be of a larval form analogous. On examination, it became palpable that these, packed together as they were, had entered *subsequently*, and were not the excavators, and this evidently bore upon the subject and suggested that Dr. Bowerbank may have been in some way deceived by appearances.

At Oddicombe Bay the shore is covered with large rolled pebbles of the limestone underlying the New Red Sandstone, and these frequently exhibited small cuplike excavations whose diameter rarely came up to the eighth of an inch, but somewhat rhythmically arranged in lines, as if communicating one with another. This appearance was caused by denudation of the surface, as the primitive aperture, where visible, was scarcely larger than the prick of a pin. It was a long time before I found any of the sponge preserved, but when I did, I saw that it clearly belonged to the species named by Mr. Hancock as *Cliona Northumbrica*, and which Dr. Bowerbank denied to be separate from the more common form. This error was so great that I doubted if the Doctor had ever seen a specimen, and may have judged from the imperfect illustrations given by Mr. Hancock. I regretted that my means and my time did not allow me to go out dredging, as I have no doubt that at a very short distance from the shore I might have found the living sponge at work.

Of course the question of the mode of producing the excavations has exercised attention, especially when we have to consider that the sarcode of the sponge is soft; and in my early examinations of the beginnings, it seemed to me that it must have been a hard substance which operated. The suggestion of some solvent seems to be inevitable, and carbonic acid has found favour with many, but it is a matter on which I can give no information. On one

occasion I was on the shore at Teignmouth, after a violent storm, making a gathering of sponges. I found one of a remarkable form, as if covering over in one part a small univalve shell. I made a careful drawing of it, and sent it to Dr. Bowerbank for information respecting it. With that courtesy so eminently characteristic of him, he immediately replied, thanking me, and referred the sponge to his *Hymeniacidon Suberea*, with an interesting account of its habits, part of which I will give you in his own words. He said, "they have the habit of enveloping shells, and, I may add, that the shells thus enclosed by the sponge are frequently destroyed, so that although, as in your specimen, the form of the shell is strikingly indicated, the substance is so completely absorbed that a needle may be passed through it without resistance."

Now, it has often occurred to me, that this bears upon the question of solvency in a very direct manner; and, in subsequent researches, I had a suspicion that this solvent power belongs also to other genera of the sponges. Thus it was that I became convinced of my previously erroneous views, though many details appeared anomalous, entirely away from our comprehension, as indeed may be said of much more that comes before us in the domain of natural history. Nor is this power of dissolving even confined to the classes alluded to, for, about thirty years ago, it was recorded in the *Comtes Rendues*, that some of the Polyzoa had the power of boring into shells, and this was first made known by Alceste D'Orbigny, who instituted the genus Teribripora for two boring polyps, which he found in South America; and M. Fischer had found some of the same family on the coasts of the Gironde and Charente Inférieure.

It is obvious, therefore, that the habit of boring into calcareous substances is not confined to one class, as it is shown to exist in Fungi, Sponges, and Polyps; and it appears to me that the suggestion made by Kölliker on the Fungi, that the operation might be due to carbonic acid may also be referred to the other organisms to which I have alluded.

Having thus fulfilled a duty which I considered I owed to myself, as well as to the Club, I now bid farewell to this chair, thanking you all for your courtesy and attention.

November 19th, 1897.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Herbert H. Smith, Mr. D. St. A. P. Western, R.N., Mr. Ralph Heap, M.A., Mr. Arthur Howard, and Dr. George M. Pittock.

The following additions to the Library were announced :—

"Journal of the Royal Microscopical Society"	In exchange.
"Proceedings of the Literary and Philosophical Society of Liverpool"	" "
"Proceedings of the Croydon Nat. History Society"	" "
"La Nuova Notarisia"	" "
"Annals of Natural History"	Purchased.
"Botanical Gazette"	From the Editor.
"The Microscope"	" " "
"The American Monthly Microscopical Journal"	In exchange.
"Science Gossip"	From the Editor.
"Proceedings of the Hist. and Sci. Society of Manitoba"	" " Society.
"Proceedings of the Ealing Natural Science and Microscopical Society"	" " "

The thanks of the Club were voted to the donors.

Mr. Goodwin inquired if any one present had noticed a paragraph in the *Daily Chronicle* to the effect that some one had invented a means of obtaining an amplification of 25,000 diameters; and wanted to know if it was likely to be correct.

Mr. Hughes said that in the *English Mechanic* for the current week there were about three columns describing a similar absurdity. Mr. Morland said it was not impossible to magnify to that extent in a roundabout way: for instance, when a highly

magnified photomicrograph was shown upon a large screen with the lantern, the original 1000 diameters was easily increased twenty or thirty times.

Mr. Goodwin said that n trying some experiments with his little lamp, he had tried to fill the field with light without using a bull's-eye condenser, and he had adopted a method of adding a small lens to the ordinary combination of the substage condenser. By this means he had been enabled to bring the lamp within 3″ of the back combination of the substage condenser, and in this way he got a full field of light without in any way impairing the definition. He thought this plan was worth the attention of those who wanted to make the best of their appliances.

Mr. E. M. Nelson said Mr. Goodwin showed him this contrivance; and having tried it, he got one made like it for himself, and although he could not say that he had exhaustively tested it, he had used it sufficiently to be assured of its merits. In the ordinary way the lamp must be placed at about 8″ from the back lens of the condenser to get the best effects. Mr. Goodwin's plan was to place a plano-convex lens of 5-inch focus in the screen holder of the condenser, which enabled him to bring the lamp up closer—namely, to 3″ instead of 8″: this gave a great increase to the intensity of the light, which was a matter of great importance when high powers were being used. He thought it was a very simple idea, and one capable of development.

Mr. George Massee then gave an interesting account of the evolution of the Basidiomycetes, which he illustrated by a fine series of coloured diagrams, and by drawings on the board.

The President invited remarks upon this most interesting communication from Mr. Massee upon a most important subject.

Mr. E. T. Newton expressed his regret that the botanists, if any were present, had not favoured them with any observations, but he thought he might say for the others that they had come into the room that evening to have many erroneous notions on the subject dispelled and to have quite a new field opened up to them. He thought those who were present would feel with him their indebtedness to Mr. Massee for giving them so much of his valuable time, and would express the great satisfaction derived from hearing his very interesting remarks. For his own part it had quite reminded him of the old days of the Club, when Dr. M. C. Cooke used to come down and give them his talks about fungi.

The President was sure they would all unite in giving Mr. Massee a very hearty vote of thanks for his interesting address, and for the exhibition of so many beautiful drawings.

The vote of thanks was put to the meeting and carried by acclamation.

Announcements of meetings, etc., for the ensuing month were then made, and the usual conversazione followed.

December 17th, 1897.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. James S. Cooke, and Mr. Robert D. Gibbs.

The following additions to the Library were announced:—

"The Botanical Gazette"	In exchange.
"Proceedings of the Royal Society" ...	" "
"The Microscope"	" "
"The American Monthly Microscopical Journal"...	" "
"La Nuova Notarisia"	" "
"Syllogæ Algarum," Vol. iv., Sect. 1 ...	From Dr. De-Toni.
"Science Gossip"	In exchange.
"Catalogue Général des Diatomacées." Part I.	By subscription.
"Annals of Natural History"	Purchased.

The Secretary said: Although probably you are already acquainted with the fact, it is my melancholy duty to refer to the death of a very early member and very good friend of the Club, Mr. Thomas Curties, which occurred on November 20th last. Probably, I may say certainly, no man ever did more for this Society than Mr. Curties. The old firm in Holborn, with which he was all his life connected, long ago acquired the reputation as a "house of call" for microscopists; and after this

Club was established hardly any purchaser of microscopical material was allowed to go until its numerous advantages were expatiated upon, and unless that man was very obdurate indeed he was as good as proposed, and thanks to the persuasive manner of Mr. Curties scores of members were added to our list. He was a very regular attendant at the meetings in those days, and everything interesting or novel which passed through his hands was sure of being exhibited and explained; but the more social functions of the Club—and these are, for the most part, only traditional now—seemed to be his particular province, and the success of the various dinners and other convivial gatherings was largely due to the unflagging energy he always showed when anything of the kind was under way. Moreover, his interest was not merely confined to proposing and directing: all the resources of the Holborn warehouse were put at the disposal of the Club in case of necessity; and if I, or any of my predecessors, was in want of microscopes, lamps, screens, or what not, all was freely provided, and often, I am afraid, at an absolute pecuniary loss. For some time past failing health prevented Mr. Curties getting here; but his interest in whatever pertained to the Club never fell off, and, although his death was not unexpected, when the end came the sense of loss was great, and many of us deeply feel the parting from an old and valued friend.

Mr. J. E. Ingpen said he should like to add a few words to those which had been spoken concerning their old friend and colleague, whose uninterrupted friendship he had enjoyed for forty-five years. The "house of call for Queketters" was a well-known term, and on looking through some of the old lists of members it was surprising to find what a number of them had been induced to join by Mr. Curties. Whilst he was Secretary of the Club scarcely a week passed without some personal communication between himself and his late friend, who always had something to suggest for the benefit of the Club, which he always considered to have been originally initiated at his house; and the last hour he spent with him was occupied in discussing a plan he wanted to carry out by getting some kind of publication of the early history of the Club. He never would, however, allow himself to be nominated on the Committee, because he felt he could be of more real service to the Club in the freer capacity of a private member. Personally he had lost an old and valued

friend, and he knew that the Club had lost a member whose interest in its welfare was of the most sincere and practical character.

The President said that the testimony borne by two Secretaries of the Club was very pleasing to hear, and it would no doubt find an echo in the minds of many of the older members of the Club. For himself he could not say that he possessed so much knowledge of their late friend, but he should always remember the kind courtesy and attention he had always received from him.

Mr. J. E. Barnard gave an interesting account of improvements in the Electric Arc Lamp which had been carried out by himself and Mr. T. A. B. Carver, in order to render it serviceable for Photomicrography Hitherto there had been very great difficulty in using this light for the purpose, because of the difficulty of keeping the position of the arc constant, and of securing a sufficiently small and uniform source of light. After many experiments they had devised a form of lamp which appeared to answer the purpose admirably. In this the distance apart of the carbon points was regulated by hand, and their position could by the same means be easily controlled, so that by reference to cross-wires on a glass screen the source of light could be always kept in the same place, whilst the oblique position in which the carbons were set enabled the small point of intense light from the incandescent crater of the positive carbon to be used as a source of unvarying and steady illumination of small area, but very great intensity. Photographs of the form of lamp employed were shown upon the screen, and the magnified images of the carbon points were projected upon another screen to show the varying effects produced by alterations in the distances and positions of the points. A number of excellent lantern slides of high-power objects, bacilli, etc., taken by the means described, were also exhibited on the screen.

Mr. E. M. Nelson said he could entirely endorse what Mr. Barnard had said with regard to the necessity in Photomicrography of having a steady source of light. He had not used the Arc Lamp himself owing to its unsteadiness. He had experienced the same difficulty with the lime light; but by reducing the pressure of the gas to about 1 inch, and using a very hard lime and a jet with a medium-sized bore, he got a fairly steady light.

Mr. Barnard said that Mr. Nelson had by the work he had done sufficiently demonstrated the capability of lime when used as he had described; yet he thought the general experience of it was that the surface of the lime was not so evenly incandesced as that of the carbon, which, in addition to being a very small and homogeneous point of light, was also much more intense. Mr. Nelson's plan was no doubt excellent and efficient, but he ventured to think that the electric lamp was better.

The thanks of the Club were unanimously voted to Mr. Barnard for his interesting communication.

Announcements of Meetings, etc. for the ensuing month were then made, and it was intimated that at the next ordinary meeting nominations for Members to fill vacancies on the Committee would be asked for.

January 21st, 1898.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., President, in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. William T. Webster was balloted for, and duly elected a member of the Club.

The Secretary called attention to a misprint which had been discovered on the title page issued with the last number of the Journal, in which "Vol. V." was inadvertently printed instead of "Vol. VI."

The Secretary mentioned that during the past month the death had been announced of Mr. Ernest Hart, a gentleman well known in connection with sanitary science, and for many years Editor of the *British Medical Journal.* Mr. Hart was the second President of the Quekett Club, having been elected in 1866 in succession to Dr. Lankester; and those whose connection with the Club extended so far back in its history well remember the very efficient manner in which he carried out the duties which devolved upon him.

The nominations made by the Committee were then read as under : —

As President .	Dr. Tatham.
As Vice-Presidents	Messrs. Waller, Dallinger, Michael, and Newton.

Other officers as before.

As Auditor on behalf of Committee, Mr. J. M. Allen.

The Secretary said it would be necessary for the members to nominate for five vacancies on the Committee in place of the four senior members who retire in rotation, and in place of Dr. Tatham, who had been proposed as President.

The following nominations were then made :—

Mr. H. Morland,	proposed by	Mr. Nelson,	seconded by	Dr. Tatham.
Mr. C. D. Soar,	,,	Mr. Harris,	,,	Mr. Travis.
Mr. F. A. Parsons,	,,	Mr. West,	,,	Mr. Macer.
Mr. E. Dadswell,	,,	Mr. Dineen,	,,	Mr. Nelson.
Mr. J. M. Allen,	,,	Dr. Measures,	,,	Mr. Powell.

As Auditor on behalf of the Club :—

Mr. W. J. Chapman was proposed by Mr. Macer, seconded by Mr. J. D. Hardy, and unanimously elected.

Dr. Measures exhibited and described a camera for photomicrography, and also a new series of lenses by Zeiss, for special use in low-power photography. In illustration of the capabilities of these lenses two large-size direct photographs of a spider were exhibited, one of which had been taken with an apochromatic lens and the other with one of the new series.

Mr. A. D. Michael said he had just taken a glance at these photographs, and thought the one taken by this new lens was, as a photograph, about as fine as could be wished, but as a zoological illustration it was quite useless, because, as the creature was flattened and rendered translucent by the method of preparation, and the photograph was taken by light passing through the object, the ventral markings were all brought out as if they were upon the back, so that he did not know of what use a photograph of that kind could be as giving any idea of the structure.

Dr. Measures said that as the object in this case was rendered

transparent, the markings would of course show through; but the capability of the lens was what, in this case, it was desired to demonstrate, and it would be equally competent to take opaque objects.

Mr. E. M. Nelson thought the photograph shown was a very remarkable one, considering the enormous area covered and the flatness of the field. He was much astonished to see that this was not accompanied by a falling off in the sharpness of the detail. As a rule large covering power is obtained by sacrificing sharpness. In the example before them this evening he thought the image as sharp, if not sharper, than any taken with the old form of lens, which had far less covering power.

A vote of thanks to Dr. Measures for his exhibits was proposed by the President, and carried unanimously.

Mr. C. Rousselet read a paper "On some Little-Known Species of *Pterodina*," illustrated by drawings.

A vote of thanks for the paper was unanimously passed.

Mr. T. B. Rosseter read a paper "On the Generative Organs of *Drepanidotænia venusta* Rosseter," in which he described his further researches into the life history of certain tænoid parasites found in ducks, and his discovery of the scolex forms. The paper was illustrated by drawings on the blackboard, and a hearty vote of thanks was given to Mr. Rosseter for his communication.

Mr. Karop said they were always exceedingly pleased to hear of the work Mr. Rosseter was doing, but unfortunately the subject was one which they were unable to discuss, because hardly any one seemed to know anything about it. Mr. Rosseter seemed to be the only one who was studying the tape-worms at the present time.

Mr. Rosseter said he quite felt his position in this respect, and should be only too glad if some one would help him in these investigations; and he asked members generally if they found anything of the kind in the course of their pond hunting to forward it to him.

Notices of meetings, etc., for the ensuing month were then made, and members were reminded that the next Ordinary Meeting would be their Annual Meeting.

Annual Meeting.—February 18th, 1898.

J. G. Waller, Esq., F.S.A., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. D. B. Scott, Mr. John Brown, Major Greenwood, jun., Mr. F. W. W. Thelwell, Mr. H. W. Symondson.

The following additions to the library were announced:—

Part XVIII. "British Moss Flora" .	From Dr. Braithwaite.
"La Nuova Notarisia"	„ the Editor.
"Journal of the Royal Microscopical Society"	„ the Society.
"Proceedings of the Bristol Natural History Society" . . .	„ „
"Handbook of British Hepaticæ." Dr. M. C. Cooke	„ Mr. A. Smith.
"Adams on the Microscope," 1746. With Plates	„ „
"Science Gossip"	„ the Editor.

The thanks of the Club were voted to the donors.

The Secretary announced the meetings for the ensuing month, and the business of the Annual Meeting was then proceeded with.

Mr. Kern and Mr. West having been appointed Scrutineers, a ballot was taken for the Officers and Council for the ensuing year.

The thirty-second Annual Report of the Club was read by the Secretary.

The Treasurer read the Statement of Accounts, and presented the audited Balance Sheet for the year ending December 31st, 1897.

Mr. Walter Bates moved that the Report and Balance Sheet be received and adopted, and that they be printed and circulated in the usual way.

Mr. Goodwin enquired if there were any stocks of the Journal in hand, and if these were not of some value.

The Secretary replied that there were most of the back numbers in the hands of the publishers, but could not say the quantity. They would, however, be very glad if Mr. Goodwin could find them purchasers.

Mr. A. W. Bird having seconded the adoption of the Report and Balance Sheet, the motion was put to the meeting and carried unanimously.

The Scrutineers having handed in their report, the President declared the following to be elected as officers and members of Council for the year 1898:—

President	J. Tatham, M.A., M.D., F.R.M.S.
Four Vice-Presidents	J. G. Waller, F.S.A. Rev. W. H. Dallinger, LL.D., F.R.S., F.R.M.S. A. D. Michael, F.L.S., F.R.M.S. E. T. Newton, F.R.S.
Treasurer	J. J. Vezey, F.R.M.S.
Secretary	G. C. Karop, M.R.C.S., F.R.M.S.
Foreign Secretary	C. Rousselet, F.R.M.S.
Reporter	R. T. Lewis, F.R.M.S.
Librarian	Alpheus Smith.
Curator	E. T. Browne, B.A., F.R.M.S.
Editor	E. M. Nelson, F.R.M.S.
Five Members of Committee	H. Morland. E. Dadswell, F.R.M.S. F. A. Parsons. J. Mason Allen, F.R.M.S. C. D. Soar, F.R.M.S.

The retiring President then read his Annual Address, at the conclusion of which he requested Dr. Tatham to take the chair as the newly elected President of the Club.

Mr. Western said he was sure the members present had listened with very great pleasure to the admirable address which had just been read by their late President, and they would no doubt desire that it should be put on record by being printed in the Journal of the Club. He had therefore much pleasure in moving that a hearty vote of thanks be given to Mr. Waller for his admirable address, and that he be requested to allow it to be printed in their Proceedings.

Mr. J. D. Hardy having seconded the motion, it was put to the meeting and carried by acclamation.

Dr. Tatham said that his first duty and his first pleasure on occupying the chair was to offer the members of the Club his cordial thanks for the honour done him by appointing him President of the Club. He had only been a few years in London, but he had been a microscopist all his life, and as soon as he was settled he put himself in communication with those of similar tastes and got some one to propose him as a member. He always looked forward to the meetings with pleasure, and had always been treated so cordially and kindly that he might say that some of the happiest hours he had spent since he came to London had been spent in that room. He hoped they would accept his hearty thanks, and at the same time his assurance of every endeavour on his part to promote the well-being of the Quekett Microscopical Club.

Mr. Marshall proposed a hearty vote of thanks to the Officers and Committee of the Club for their most valuable services during the past year.

Mr. Stokes seconded the motion, which was put to the meeting by the President and carried unanimously.

Mr. J. J. Vezey said that, probably on account of his youth and inexperience, he had been deputed to respond for his colleagues, and could only say on their behalf that he thanked the members for the expression of their approval, and assured them that it was a great source of pleasure to be able to assist in the management of the Club. For his own part he could certainly say that he was never so happy as when taking their subscriptions, and he was quite sure that their Honorary Secretary was always equally happy to receive the names of new members and of the readers of papers.

Mr. J. W. Reed proposed a vote of thanks to the Auditors and Scrutineers. This was seconded by Mr. D. Bryce, and being put to the meeting by the President was unanimously carried.

The Secretary again called attention to a misprint on the title-page of the last volume of the Journal, where "Vol. V." had inadvertently been printed instead of "Vol. VI."

THIRTY-SECOND ANNUAL REPORT.

Your Committee is once more enabled to present a favourable Report of the Club's concerns, at the end of another year. If little that is extraordinary calls for record, neither has any circumstance interfered with its wonted course.

Twenty-seven members have been elected, and the same number lost by resignation or death. Amongst the latter is Mr. T. Curties, of Holborn, one of the Club's earliest and most enthusiastic members, who for many years exerted himself in every possible way to further its welfare and progress; and, although prevented latterly by failing health from attending our meetings, was as interested as ever in our proceedings until the last. The more social functions of the Club were the special objects of his solicitude, and those among us who remember the Soirées and the Annual and Excursion Dinners of times gone by will never forget Mr. Curties's unflagging energy and great organising abilities, to which their success was so largely due.

The Meetings have been as well attended as usual, and the matter submitted at them has maintained a high character. The following is a list of the more important papers:—

January .	On a New Metopidia . . .	Mr. Dunlop.
,, .	On the varieties of Brachionus Bakeri	Mr. Rousselet.
March .	On the experimental infection of the domestic Duck with Cysticerci	Mr. Rosseter.
May . .	On the Mycetozoa	Mr. Slade.
,, . .	On the minute structure of certain Diatoms	Mr. Nelson.
June . .	On collecting Foraminiferous material	Mr. Earland.
,, . .	On the male of Proales Wernecki (preliminary)	Mr. Rousselet.

October .	On the logarithmic plotting of certain Biological data . .	Mr. Scourfield.
November	On the evolution of the Basidiomycetes	Mr. Massee.

Besides these a number of short Notes on various subjects and descriptions of new or improved apparatus were brought forward, and will be found in the Proceedings.

Your Committee desires to tender its special thanks to Mr. G. Massee, of Kew Gardens, who gave a most interesting address on the evolution of the Basidiomycetes at the November meeting, which was illusrated by a large number of beautiful drawings; and to all those gentlemen who have done so much to render the gatherings both profitable and pleasant, not alone by reading papers, but also by bringing their instruments and exhibiting living or mounted specimens.

For some time past it had been noticed that the attendance at the September Ordinary Meeting fell much below the average, probably from so many being away on their holidays. It was felt by your Committee to be hardly fair to your officers to bring them back for so small an affair, and a proposal was made to delete this meeting. The question was submitted to the members according to rule, and unanimously adopted. The third Friday in September, therefore, will henceforth be a conversational meeting only, and, like the great majority of other societies, we shall have a three months' vacation.

A Special Exhibition Meeting was held in May at the Smaller Queen's Hall, Langham Place. The arrangements were kindly undertaken by Messrs. Dadswell and Vezey, and the services of an excellent band were secured through the kind offices of Mr. J. W. Reed. The acknowledged success of the evening was very largely due to these gentlemen, and your Committee embraces this opportunity of offering to them the best thanks of the Club, and putting on record its appreciation of their willing sacrifice of time and trouble.

The following is a list of the additions to the Library during the year:—

Dr. M. C. Cooke's "Handbook of British Hepaticæ"	Presented by Mr. Alpheus Smith.

Adams' "Micrographia Illustrata," First Edition, 1746	Presented by Mr. Alpheus Smith.
Buckler's "Larvæ of the British Butterflies and Moths," Vol. VII. . . .	By Subscription.
"The Tailless Batrachians of Europe," Part I. By G. A. Boulenger . .	"
"Quarterly Journal of Microscopical Science"	Purchased.
"Annals and Magazine of Natural History"	"
"Journal of the Royal Microscopical Society"	In Exchange.
"Proceedings of the Royal Society" .	"
"Le Diatomiste"	"
"La Nuova Notarisia"	"
"American Monthly Microscopical Journal"	"
"The Microscope"	"
"International Journal of Microscopy" .	"
"American Botanical Gazette" . .	"
"Proceedings and Transactions of various Societies"	
Sundry Pamphlets	

A third catalogue, of the Botanical and Chemical preparations and Rock sections, has been printed since the last Report, and a classified list of the Tatem Collection of Insects is being prepared by Mr. C. Turner.

The Journal issued in December forms the concluding part of Volume VI. of the Second Series.

With regard to the financial position, it must be pointed out that the expenses of the period covered by the Report are about £50 higher than in 1896, and indeed they are in excess of the receipts: this is chiefly due to two items—viz., the Journal and the Exhibition Meeting. Your Committee does not begrudge this outlay, but it shows the necessity for members to keep up their numbers, as a Society, unlike an individual, cannot long continue to live beyond its income. It may also be noted that the receipts from advertisements do not appear so large as last year: this is not due to any lack of energy on the part of Mr.

Rousselet, who kindly manages this department, but simply that the late issue of the last number of the Journal rendered it impossible to collect the amount due in time to include it in the 1897 accounts.

Your Committee has again to express its appreciation of the efficient manner in which the manifold affairs of the Club have been carried on by the several officers, and its best thanks are due to them for their services.

Finally, from a consideration of the past, your Committee is hopeful of the future of the Club. So long as the promotion of its welfare continues to be regarded as a duty by its members—which does not appear to be doubtful—its continued career of utility and prosperity seems assured; but no feeling of confidence should prevent each from doing his utmost to further the interests of a Society like this, which from the first has entirely depended on voluntary, individual effort, freely given for the advantage of all.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB.

For the Year ending 31st December, 1897.

Dr.	£	s.	d.
To Balance from 1896	214	19	6
,, Subscriptions received in 1897	160	0	0
,, Compounding Fee	10	0	0
,, Dividends on Investments	6	10	8
,, Sale of Journals	18	12	0
,, Sale of Catalogues	0	17	9
,, Receipts for Advertisements	13	16	6
,, Unused Cheques—Stamps credited	0	0	8
	£424	17	1

Cr.	£	s.	d.
By Rent of Rooms and Bookcases	54	12	0
,, Expenses of Journal	107	18	7
,, Investment in Metropolitan Stock	50	0	0
,, Postage	4	16	0
,, Printing and Stationery	13	0	5
,, Attendance	6	0	0
,, Books, etc., purchased	8	14	6
,, Expenses of Conversazione	18	16	0
,, Petty Expenses	2	3	0
,, Balance in hand	158	16	7
	£424	17	1

	£	s.	d.
Moneys invested in £2 15*s*. Consols	200	0	0
,, ,, Metropolitan Stock, $2\frac{1}{2}$ per Cent., cost £50	49	5	2
	£249	5	2

J. J. VEZEY, *Hon. Treasurer.*

We have examined the above statement of Income and Expenditure, and compared the same with the Vouchers in the possession of the Treasurer, and find the same correct.

W. INGRAM CHAPMAN, } *Auditors.*
J. MASON ALLEN, }

February 7th, 1898.

Q. M. C. EXCURSIONS, 1897.

Reference Number.			No. of Members of the Q. M. C. attending.	No. of Members of other Societies attending.	No. of Visitors.	Total.
1	March 27	Loughton	12	—	—	12
2	April 10	East End, Finchley	12	—	—	12
3	May 1	Royal Botanic Gardens	34	11	7	52
4	May 15	Keston	15	—	1	16
5	May 29	Totteridge	5	—	—	5
6	June 12	Whitstable*	—	—	—	—
7	June 26	Staines	6	—	1	7
8	July 10	Hanwell	10	—	—	10
9	July 24	Hertford Heath	5	—	—	5
10	Sept. 4	Esher	6	—	—	6
11	Sept. 18	Oxshott	5	—	—	.
12	Oct. 2	Snaresbrook	11	1	—	12

* The excursion to Whitstable had to be abandoned in consequence of a sufficient number of members not sending in their names.

Names of Members who sent Lists of Objects Found by them.

B.	Burton, W.	Si.	Sidwell, C. J. H.
M.	Measures, J. W.	S.	Soar, C. D.
P.	Parsons, F. A.	T.	Turner, C.
R.	Rousselet, C. F.		

List of Objects Found on the Excursions.

Note.—The numbers following the names of the objects indicate the Excursions upon which they were found, and the letters indicate the names of the members recording the same. When an object is frequently recorded the names of the members are omitted.

CRYPTOGAMIA. ALGÆ.

Batrachospermum moniliforme . . . . 12, P.
Draparnaldia glomerata . . . . . 4, P.
Gonium pectorale . . . . . . 1, B.; 2, 11, M.
Pandorina morum . . . . . . 1, B.
Pediastrum Boryanum . . . . . 8, T.
Protococcus viridis . . . . . . 2, B.
Raphidium falcatum . . . . . . 4, T.
Scenedesmus quadricauda . . . . . 4, 8, T.
Spirulina oscillarioides . . . . . 7, T.
Stephanospæra pluvialis . . . . . 11, M.
Volvox aureus . . . . 12, M.
„ globator . . . . 2, B., M.; 7, M.; 8. Si.; 11, M.
Zygnema cruciatum . . . . . . 7, T.

Desmidiaceæ.

Closterium lunula . . . . . . 2, B.; 5, 9, T.
„ rostratum . . . . . . 5, 9, T.
„ setaceum . . . . . . 4, 5, 9, T.
Docidium baculum . . . . . . 4, 5, T.

PHANEROGAMIA.

Drosera rotundifolia . . . . . . 4. Si.

PROTOZOA.

Actinosphærium Eichhorni . . . . 3, 11, 12, M.
Actinophrys sol . . . . 1, 2, 3, B.; 8, T.
Amœba radiosa . . . . 11, M.
Amphileptus gigas . . . . . . 2, T.
Anthophysa vegetans . . . . . . 9, P., T.; 11, P.
Arcella dentata . . . . 1, B.
„ vulgaris . . . . 1, 2. B.; 8, T.

Bursaria truncatella	1, B.; 2, T.
Carchesium polypinum	3, B.
Clathrulina elegans	2, P.
Coleps hirtus	1, B.: 2, 3, T.; 11, P.
Condylostoma stagnale	1, B.: 2, T.; 3, B., T.; 5, T.
Cothurnia imberbis	3, B., T.
Dendromonas virgaria	5, T.
Didinium nasutum	8, P.
Difflugia aculeata	8, M.
,, acuminata	11, M.
,, globulosa	4, T.; 7, M.; 8, 11, M., T.
,, oblonga	11, T.
,, pyriformis	3, B.
Dinobryon sertularia	1, B., T.; 2, 4, T.; 5, P., T.; 11, T.
Euglena viridis	1, 2, B.; 8, Si.
Euplotes patella	1, 2, 3, B.; 5, 9, 11, T.
Loxophyllum meleagris	9, T.
Mallomonas Plosslii	2, T.
Paramecium aurelia	1, 2, B.; 3, 8, T.
Peridinium tabulatum	2, B., T.; 3, B.; 4, 5, 9, T.
Phacus longicaudus	3, B.; 5, T.
Pyxicola Carteri	3, P.
Rhipidodendron Huxleyi	11, P.
Spirostomum ambiguum	5, 8, 11, T.
Stentor niger	1, B.; 2, B., T.; 5, 9, T.; 12, P.
,, polymorphus	2, 3, 5, 7. 8, 9, 12.
Stylonichia mytilus	5, T.
Trachelius ovum	1, B., T.; 3, B., P., T.
Trachelocerca olor	2, 9, T.
Urocentrum turbo	5, T.
Vaginicola crystallina	2, 3, 5, 10, T.
Vorticella chlorostigma	7, P.
,, nebulifera	8, M.
,, nutans	8, M.

CŒLENTERA. HYDROZOA.

Hydra fusca	8, M., Si.
,, viridis	2, B., M.; 8, Si.; 12, M.
,, vulgaris	2, B.; 11, 12, M.
Limnocodium Sowerbii, polyp stage	3, P.

ROTIFERA.

Actinurus neptunius	2, M, T.; 5, P.; 9, T.
Anuræa aculeata	1, 2, 3, 4, 5, 7, 8, 9, 10.
,, ,, var. brevispina	1, 2, M.; 5, R., T.; 9, P., R.; 10, 11, T.; 12, M.
,, ,, ,, valga	1, M.; 2, R.; 12, R.
,, ,, ,, ,, male	2, R.
,, cochlearis	1, 2, 3, 4, 8, 12.
,, curvicornis	1, B.; 2, 9, T.; 11, 12, M.

Anuræa hypelasma	2, M., R.; 5, R.; 8, M.; 9, R.; 11, M.; 12, R.
,, serrulata	1, 2, 4, 11, 12.
,, tecta	2, T.; 5, R., T.; 8, R.; 11, T.
Ascomorpha ecaudis = Sacculus viridis	2, 4, 5, 9, 11, 12.
Asplanchna amphora	9, P., R., T.
,, ,, male	9, T.
,, Brightwelli	2, B., M., R., T.; 3, T.; 5, R.; 8, M., T.
,, ,, male	2, M., R.
,, intermedia	8, R.
,, priodonta	2, 3, 4, 8, 12.
Brachionus angularis	1, 2, 3, 5, 7, 8, 10.
,, Bakeri	3, 8, 11, 12.
,, pala	2, 3, 5, 8.
,, ,, var. amphiceros	3, P.
,, rubens	1, B.; 7, M.; 8, P.
,, urceolaris	1, 2, 3, 5, 8, 11, 12.
,, ,, male	12, M.
Cathypna rusticula	5, R., T.; 7, 11, M.
,, sulcata	4, T.
Cephalosiphon limnias	5, R.; 12, M.
Cœlopus brachyurus	4, R.; 5, T.; 4, 12, R.
,, porcellus	1, R.; 2, T.
,, tenuior	10, T.; 12, R.
Colurus bicuspidatus	2, B.; 3, T.; 4, R.; 5, 9, T.
,, caudatus	9, T.
,, leptus	3, B.
Conochilus volvox	1, B., M., R.; 4, Si.
Copeus caudatus	5, R.
,, cerberus	3, R.
,, Ehrenbergi	7, M.
,, pachyurus	3, M.; 5, 9, T.; 11, 12, M.
Cyrtonia tuba	9, R., T.
Diaschiza exigua	12, R.
,, Hoodi	12, R.
,, semi-aperta	1, T.; 3, R.; 8, T.; 9, R.; 11, M., T.
,, valga	1, 10, T.
Diglena catellina	3, R.; 8, P.
,, rosa	2, R.
Dinocharis pocillum	1, B.; 2, M., R.; 4, R., T.; 9, R.
,, tetractis	1, 2, 5, 7, 9, 11, 12.
Distyla flexilis	1, M.; 10, T.; 11, M.
Eosphora aurita	5, R.; 11, M., P., T.
,, digitata	2, 8, R.
Euchlanis deflexa	3, B.; 4, R.; 5, R., T.; 7, P.; 8, R.
,, dilatata	1, 2, B.; 3, 5, T.; 7, M.

Euchlanis hyalina	5. 7, P.: 9, 11, T.; 12, R.
,, lyra	1, M., P., R., T.
,, oropha	1, R.; 7, M., P.; 8, M.
,, propatula = Diplois propatula (Gosse)	9, R., T.; 11, M., P., T.
,, pyriformis	3, B.
,, triquetra	1, 5, 7, 11, 12.
,, ,, male	12, R.
Floscularia calva	5, T.
,, campanulata	5, P., T.: 12, R.
,, cornuta	3, B.; 12, M., P.
,, longicaudata	11, M.
,, ornata	1, T.
Furcularia æqualis	5, P.
,, forficula	9, T.
,, longiseta	2, 4, 9, 11, 12.
,, ,, var. grandis . .	9, R.; 11, M.
Hydatina senta	1, M.; 5, T.: 8, P., T.
Limnias annulatus	3, P.
,, ceratophylli	3, B., P., R.; 5, R.
,, cornuella	3, M.
Mastigocerca bicornis	1, 4, 5, 9, 11.
,, bicristata	5, R.; 11, T.
,, carinata	1, B.; 5, R.; 7, P.
,, rattus	2, M., R., T.; 5, R., T.; 7, M.; 8, R.; 11, R., T.
Melicerta conifera	5, P.; 12, M.
,, ringens	2, 3, 5, 7, 8.
,, tubicolaria	7, P.
Metopidia acuminata	1, M.; 5, T.; 11, P.; 12, P. R.
,, lepadella	1, R.: 2, B., R.; 4, R.: 7, M.
,, rhomboides	7, M.: 9, T.
,, solidus	1, 3, 4, 5, 7, 8, 11, 12.
Microcodides doliaris (Rousselet) . .	9, T.; 11, P., T.
,, orbiculodiscus = stephanops chlœna	4, T.; 9, R.. T.
Microcodon clavus	1, 4, T.
Monostyla cornuta	12, R.
,, lunaris	1, M., T.; 5, 8, T.
Noteus quadricornis	5, P., T.: 7, M., P.; 8, P.; 9, P., T.; 12, P.
Notholca acuminata	1, M.; 2, M., R., T.; 3, B., M., R., T.
,, scapha	1, B., M., R.; 2, 3, B., M., R., T.; 10, T.
Notommata aurita	3, P., R.; 5, 9. R.; 12, P.
,, brachyota	11, T.
,, lacinulata	2, R., T.; 7, P.; 11, T.; 12, M., P., R.

Notommata pilarius	7, P.
,, saccigera	1, R. ; 11, T.
Notops brachionus	5, 9, 11, 12.
,, ,, male	11, M.
,, hyptopus	1, 5, 11, 12.
,, ,, male	12, R.
,, minor	12, P., R.
Œcistes crystallinus	3, B., P. ; 5, P., R., T.
,, intermedius	3, T. ; 8, M.
,, pilula	11, M.
,, umbella	1. B.
Pedalion mirum	9, P., R., T.
Philodina aculeata	8, P.
,, citrina	3, R. ; 4, P.
,, macrostyla	4. P.
,, megalotrocha	3, B., T. ; 8, M., P.
Polyarthra platyptera	1, 2, 3, 4, 5, 8, 9, 10, 11, 12.
Pompholyx sulcata	12, M., R.
Proales parasitica	9, T.
,, petromyzon	2, T. ; 3. B., T. ; 11, T.
,, sordida	2, R.
Pterodina cœca	1, R., T.
,, patina	1, 2, 3, 7, 8.
Rattulus bicornis	12, R.
Rhinops vitrea	2, B., M., R., T. ; 5, T. ; 12, R.
Rotifer macroceros	3, 4, 7, 11, P.
,, macrurus	3, B. ; 8, M. ; 9, P., T. ; 12, M., P.
,, tardus	7, 11, P.
,, vulgaris	1, B. ; 3, B., P.
Salpina brevispina	1, M. ; 2, R. ; 5. P., R., T. ; 7, M.
,, macracantha	7, M. ; 8, 12. R.
,, marina	2, R.
,, mucronata	1, 2, 3, 4, 5, 8, 9.
,, mutica	5, P.
,, spinigera	12, R.
Scaridium longicaudum	2, B. ; 5, R., T.
Stephanoceros Eichhorni	2, M. ; 5, P., R., T. ; 7, P. ; 12, R.
Stephanops intermedius	12, R.
,, lamellaris	2, R. ; 5, R., T. ; 7, M. ; 12, R.
,, muticus	11, M.
Synchæta gyrina	2, R. ; 3, 11, M.
,, pectinata	1, 2, 3, 4, 5, 7. 8, 9, 11, 12.
,, stylata	8, R.
,, tremula	2, 3, 5, 7, 8, 10, 11, 12.
Taphrocampa annulosa	1, B. ; 4, P. ; 11, M. ; 12, P. R.
Triarthra breviseta	2, B.
,, longiseta	2, 3, 5, 8, 9, 10.
,, mystacina	2, P., R. ; 5, R. ; 8, T. ; 12, R.
Triphylus lacustris	9, P., R., T.

GASTROTRICHA.

Chætonotus larus	9, T.
,, maximus	9, T.

VERMES. PLATYHELMINTHES.

Cercarian stage of a trematode worm	7, P.

ARTHROPODA. CRUSTACEA.

Entomostraca.

Alona quadrangularis	8. Si.
Bosmina longirostris	3. B.
Canthocamptus minutus	1, 2, 3. B. ; 4, Si.
Ceriodaphnia rotunda	8, Si.
Chydorus globosus	3, B. ; 8, Si.
,, sphericus	1, B. ; 4, 8. Si.
Cyclops fuscus	4, Si.
Daphnia pulex	1, B. ; 4, 8, Si.
,, magna = D. Schæfferi	1, B. ; 4. Si.
Diaptomus castor	1, 2, B.
,, gracilis	3, B.
Eurycercus lamellatus	1. B.
Ilyocryptus sordidus	3, B.
Simocephalus vetulus	4, 8, Si.

ARACHNIDA. Acarina.

Hydrachnidæ.

Arrenurus albator	5, S.	
,, caudatus	5, S.	
,, globator	1, 4, 5, S. ; 8. Si. ; 11, M. ; 12. S.	
,, sinuator	4,	
Atax crassipes	5. 12.	
Atractides spinipes	2.	
Axona versicolor	1. 2, 4.	
Bradybates truncatus	1,	
Cochleophorus vernalis	2, 12	
Diplodontus despiciens	7, 12.	
Eylais extendens	5.	S.
Hydrachna globosa	5,	
,, punicea	5,	
Hydrodroma rubra	5.	
Hygrobates hemisphæricus	4.	
Limnesia fenestrata	2, 4,	
,, histrionica	2, 4, 5, 12,	
Marica musculus	5,	
Nesæa conglobatus	2, 5, 10,	
,, longicornis	4. Si.	

Nesæa obturbans	4,	S.
„ rufus	2.	
Oxus oblongus	4,	
Piona affinis	5,	
„ ovata	5,	
„ rufa	5,	

ARCTISCONIDÆ.

Macrobiotus Hufelandi	3. P., T. ; 4. S. 12, P.

INSECTA.

DIPTERA.

Corethra plumicornis, larva of	8, Si.
Culex pipiens, larva of	8, Si.

HEMIPTERA.

Notonecta glauca	

NEUROPTERA.

Ephemera vulgata, larva of	8, Si.

BRYOZOA.

Alcyonella fungosa	12, M.
Fredericella sultana	3, B., M., T.
Paludicella Ehrenbergi	3, B., T.
Plumatella repens	3, B. ; 8, M.

FREDK. A. PARSONS,
Hon. Sec. Excursions Sub-Committee.

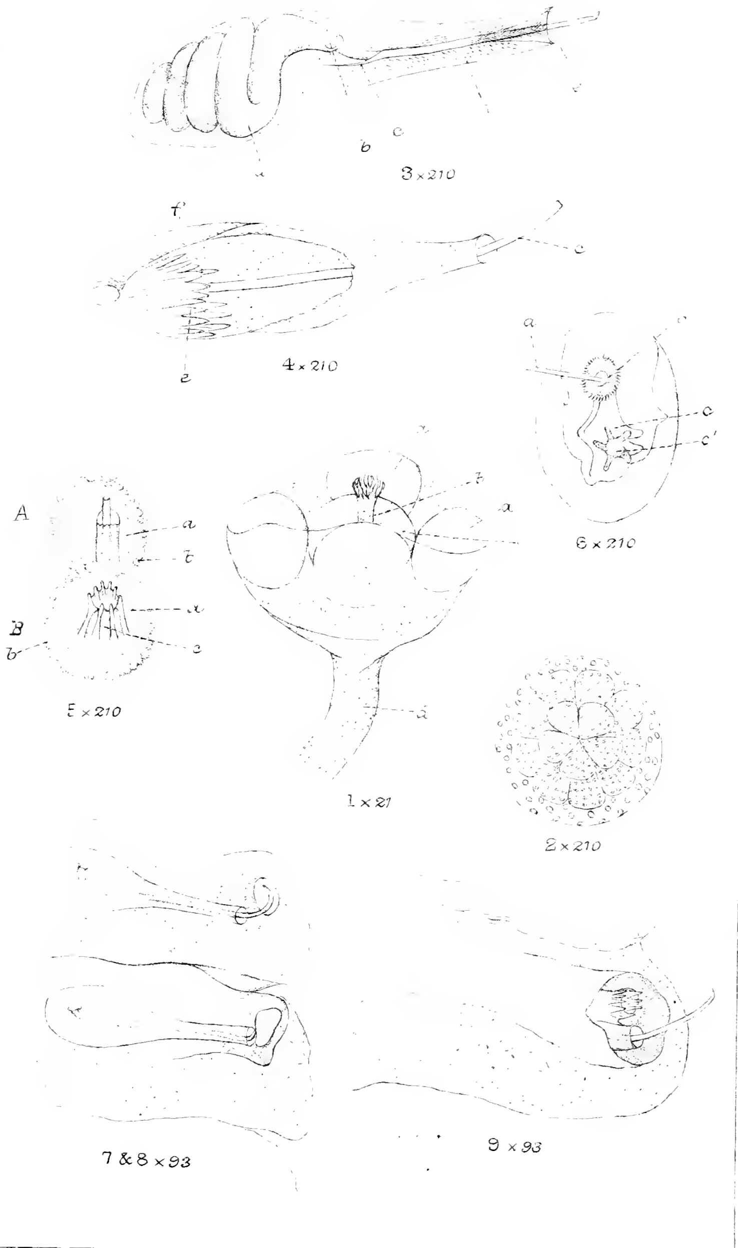
Notices of Books and Periodicals.

L'Intermédiaire des Biologistes. Paris: Librairie C. Reinwald, 15, Rue des Saints-Pères. Published fortnightly, subscription, post free, 12 fcs.

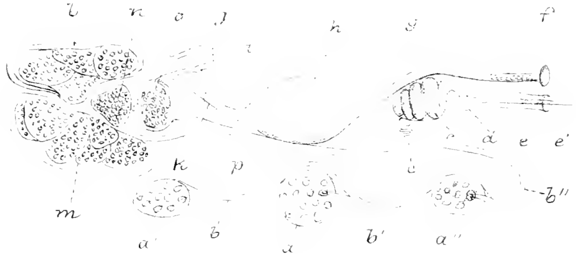
This is likely to be a very useful periodical for naturalists. It is a kind of scientific "Notes and Queries," as in the specimen before us (No. 5) the bulk is occupied by questions and answers, and this is its chief intention. Any subscriber is at liberty to forward to the directors questions on any biological matter in which he finds himself in difficulty, and replies are accepted in most European languages, of which short summaries are given in French under the originals. These replies must be signed, but the questions may be anonymous. The whole is under the direction of Drs. Alfred Binet and Victor Henri, with the collaboration of a number of eminent scientists, a list too long to quote here, but all of international reputation. The scheme includes original work, and also a summary of the contents of current scientific periodicals, and descriptions of new apparatus. Its obvious utility and low subscription should, and no doubt will, procure for it numerous subscribers.

Journal of Applied Microscopy. London: Dawbarn & Ward, Ltd. Subscription, post free, 5*s*.

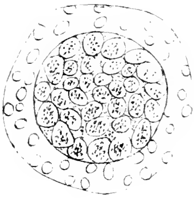
This is an American monthly, emanating from the well-known Bausch & Lomb Optical Co., of Rochester, N.Y. It contains a number of methods of observation and experiment, descriptions of bacteriological and other apparatus, and a selection of abstracts. There is also a projected series of articles on "Representative American Laboratories," beginning with those of Cornell University in the February number, which is well illustrated throughout.



T.B. Rosseter, F.R.M.S. del. West, Newman lith.

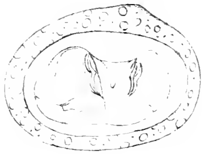


10 × 62

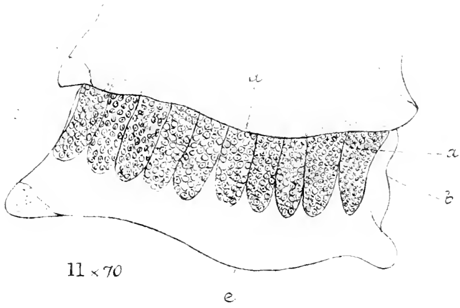


12 × 350

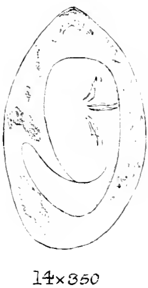
17 × 400



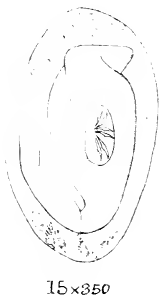
13 × 350



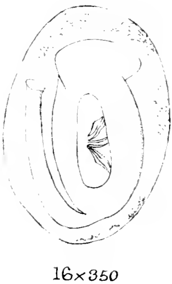
11 × 70



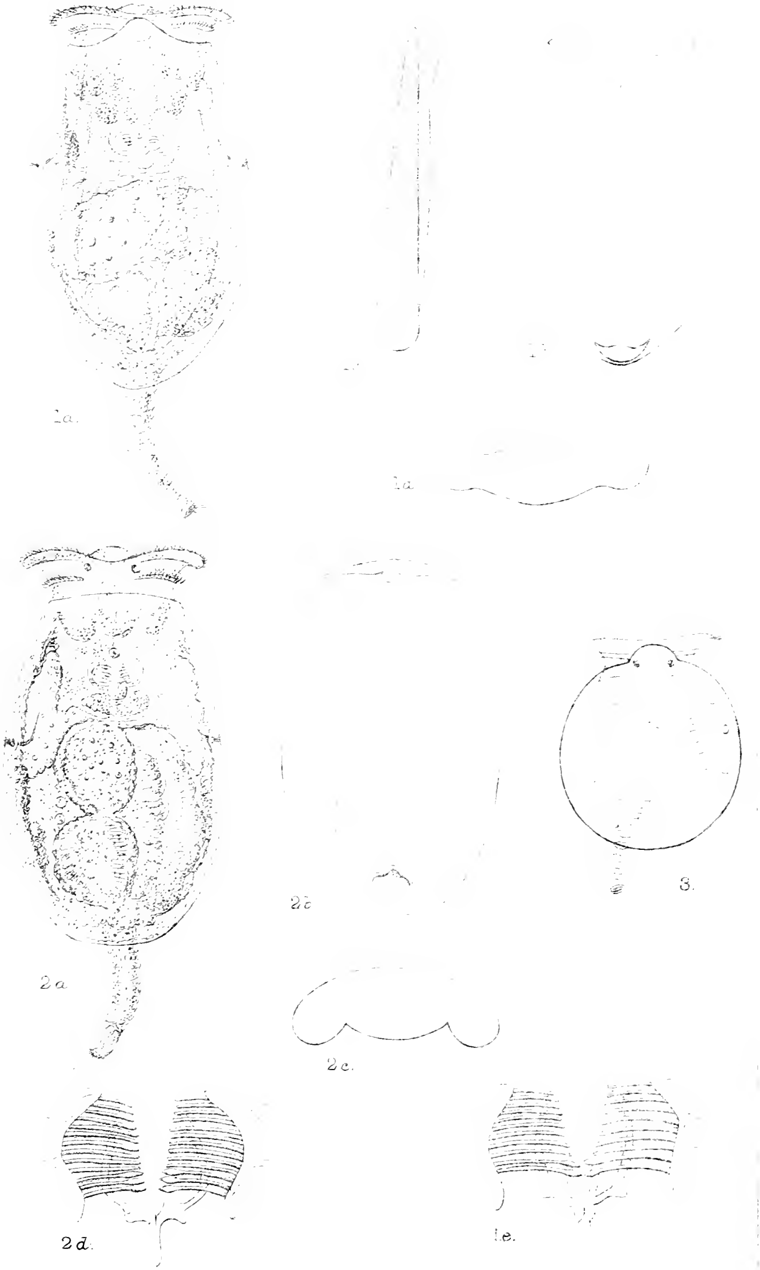
14 × 350



15 × 350



16 × 350



C.F. Rousselet & F.R. Dixon-Nuttall del at nat

West, Newman imp.

Pterodina.

C.F. Rousselet & F.R. Dixon-Nuttall del at nat

West, Newman imp

Pterodina.

8a

8b

6.

9.

C F Rousselet & F R Dixon-Nuttall del at nat West, Newman imp.

Pterodina

The Æcidium Stage of Uromyces Pisi on Euphorbia Cyparissias.

By J. W. Reed.

(*Read March* 18*th*, 1898.)

Plate 6.

During some readings in Kerner's "Natural History of Plants" just before my last annual holiday in the Alps, I specially noted a passage referring to the metamorphosis produced by the parasitism of *Uromyces pisi*, in its Æcidium stage, in one of the Spurges growing freely at Saas-Fée in the Canton Valais.

The Spurge in question was the *Euphorbia Cyparissias*, a Central and Southern European species, and only known in Britain as a cultivated plant, though in some places it has escaped and partially established itself. Last summer, as in that of 1896, my mountaineering companion was Mr. George Nicholson, the Curator of Kew Gardens, and on our arrival at Saas-Fée we began without delay a search for healthy and infected plants of the Euphorbia; nor had we far to seek. The mounted specimens exhibited this evening are average samples of what came under our notice. Only the most cursory examination of these plants is necessary to show the extraordinary changes induced in the tissues, colour, and general habit of this Spurge—changes so great that diseased and healthy plants would scarcely be recognised as belonging to the same species or even genus.

It will be seen at a glance that whilst in the non-infected plants the leaves are thin, linear, and of a somewhat deep green, the whole habit being bushy, in the diseased ones the leaves are short and thick, the colour a dusty yellow, and the stems look naked and stalky, and do not branch. I have measured the healthy leaves, and find them from seven to fourteen times as long as they are broad; the leaves with Æcidia are only about four times as long as broad, and are placed more widely apart than are those of the normal Euphorbia. Elongation of the stem

and shortening and thickening of the leaves are the usual result of an attack by a Uredine. The mischief wrought in the host-plant is consummated by the resultant abortion of the floral organs, and their consequent sterility.

I have also counted the Æcidia on my infected plants, and find they average roughly about fifty to each leaf. They are about one-third of a millimetre in diameter. A former President of this Society, Dr. M. C. Cooke, once computed the number on a leaf of the Yellow Goat's-beard (*Tragapogon pratensis*) as 3,000; even allowing for the great difference in the size of the leaf, the Æcidia on my specimens are not so numerous as this. Dr. Cooke estimated that the individual Æcidium contained 250,000 spores, each of which, given suitable conditions, would be sufficient to inoculate a healthy plant, and form a new centre of disease.

I am sorry that the sections I am exhibiting in connection with this subject are not more successful; I ought to have put the fresh material into some preservative fluid there and then, and not trusted to Herbarium material. This I found too dry, crushed, and distorted, and, in cutting, it constantly tended to crumble up.

Uromyces pisi—as its specific name indicates, a pest to the pea-grower—belongs to the Uredineæ, a large group of parasitic fungi of which 400 or 500 species have been determined. The more extreme abnormal growths brought about by the Æcidia of the Uredineæ on the host-plants are well illustrated by the bushy excrescences popularly known as "Witches' Brooms"; often seen on the Silver Fir (*Abies pectinata*), and other trees. *Ustilago esculenta*, one of the Ustilagineæ, causes considerable swelling of the base of the stem of a species of grass, which, in this abnormally succulent condition, is sold as a vegetable in the Japanese markets.

Less than a hundred years ago, had any one ventured a statement that certain fungi passed a part of their lives on one plant and part on another not even remotely related botanically, it would probably have been received with almost contemptuous incredulity. Even up to a comparatively recent date the Æcidia, or so-called "Cluster Cups," which, either seen in section or by reflected light as opaque objects under the microscope, are so beautiful and interesting, were regarded as a separate genus of

Fungi. It was not recognised that the Æcidium was only a stage, or a special form of fructification, in the life-cycle of particular groups of Fungi. But this condition of things, known as Metœcism or Heterœcism—the former was the term used by De Bary, the discoverer—is now a well-known fact, firmly established by the sure method of questioning Nature herself by careful and prolonged observation and experiment. This method, as applied to the Fungi referred to, is happily neither expensive nor difficult.

There is a much dreaded Fungus, and the best known species of the Uredineæ, called *Puccinia graminis*—the mildew of wheat—which appears to have been the first Uredine whose cyclic development was noted. Mr. Massee, of the Royal Herbarium, Kew, in his "Evolution of Plant Life, Lower Forms," selects this species as a typical one, and there describes its life-history. For some time prior to a scientific inquiry into the matter, it had been widely and strongly suspected, by quite unscientific people, that with regard to the spread of *Paccinia graminis* there was a mysterious connection between it and the proximity of Barberry bushes.

Quite recently a friend noticed at the railway station at Thorney, in Cambridgeshire, some barberries infected with Æcidia, further observation showing a band of discoloration extending from these bushes right across an adjoining wheat-field. The area of discoloration corresponded in width with the space occupied by the diseased shrubs, and marked the track of innumerable wind-borne spores. Similar phenomena, although their philosophy was unknown, must have been frequently observed by agriculturists in the past; hence their mistrust.

This suspicion took practical effect in Massachusetts, more than a century ago, by the passing of an Act known as the Barberry Law, compelling, for the sake of agriculture, the destruction of the barberry bushes. Part of the first clause reads thus:—"Whoever, whether community or private person, hath any Barberry Bushes standing or growing in his or their land, within any of the towns in this Province, he or they shall cause the same to be extirpated or destroyed on or before the thirteenth day of June, Anno Domini One thousand seven hundred and sixty."

Farmers in England also believed that in some way the barberries

were instrumental in propagating the blight on the wheat; and an author, writing in 1781, and quoted by Mr. Plowright, says that he found by actual observation that the barberries had been widely removed from the hedges of Norfolk. As might have been expected, many wild and fantastic suggestions were made as to this hypothetical relation of the barberry to the mildewed corn-fields. At length, however, in 1816, the true connection was demonstrated by a Danish schoolmaster, who rubbed the underside of a barberry leaf, infected with Æcidia, on to some plants in a field of rye, so that some of the Æcidiospores were left on them. The rye plants thus treated were marked by being tied to sticks. In a few days the fungus had spread itself widely over the plants in question, whilst all others in the field were free from disease. It may be mentioned here that to-day, in the Swiss Alps, the precautionary removal of the barberry bushes is too much neglected, to the great detriment of the wheat-fields.

Mr. Plowright, in his delightful Monograph on the "British Uredineæ and Ustilagineæ," which is well worth the attention of every member of this Society, says: "In 1861, De Bary showed that many of the Uredineæ not only had uredospores and teleutospores, but also that the latter gave rise in many cases (but not in all) to æcidiospores, and conversely the æcidiospores to uredospores. . . ."

(These several forms of spores will be more particularly dealt with later on.)

"It further occurred to him that, as there were several æcidia unaccompanied on the host-plants by any other spore form, these might belong to Uredines which passed a part of their life upon one plant and the remainder upon another." This supposition Professor De Bary demonstrated to be correct in 1864.

The real relations of *Uromyces pisi* and what was up to then known as "Æcidium cyparissiæ" were worked out by Schröter, in 1875. Schröter was the first to produce the æcidial stage on our Euphorbia from *Uromyces pisi.*

Mr. Massee, whose paper on the "Evolution of the Basidiomycetes," recently read before this society, will long be remembered with pleasure and profit, has been good enough to examine my specimens, and has favoured me with the following notes for inclusion in this communication:—

"The mycelium of the æcidium or 'cluster-cup' stage of *Uromyces pisi* (De Bary) is perennial in the tissues of the host; hence, when plants are once attacked they never recover, but produce the fungus year by year. The æcidiospores, produced in the 'cluster-cups,' are dispersed by wind at maturity, and those that happen to alight on a leaf of the common pea (*Pisum sativum*) germinate within a few hours if the surface of the leaf is damp; the germ-tube bores through the epidermis, enters the tissues of the leaf and there forms a mycelium.* About fourteen days after infection, the mycelium produces dense tufts of uredospores, which burst through the epidermis at maturity, and are distributed by wind and rain. Those uredospores that alight on pea-leaves germinate quickly, enter the tissues of the leaf, and, in turn, produce other clusters of uredospores. The clusters of uredospores are pale brown. Uredospores are called summer-spores, their function being to enable the fungus to extend its area of distribution. Produced in enormous quantities, and very rapidly throughout the summer, it is easy to understand the swiftness with which the disease can, and does spread; the only limit being lack of supply of pea-plants for it to attack.

"In the autumn, when the host-plant is waning, a second form of spore is produced from the same mycelium that produced the uredospores earlier in the season. This second form of spore is known as a teleutospore, or winter spore, and differs from the uredospore in requiring to remain in a latent condition before it can germinate. The function of teleutospores is to tide the fungus over that part of the season—its season of discontent—when the host-plant is not present for it to prey upon. After remaining in a resting-stage during the winter, the teleutospores germinate in the spring, and give origin to still smaller spores called sporidiola or secondary spores. These exceedingly minute secondary spores are, as usual, dispersed by wind, and those that

* This mycelium, or vegetative portion of the fungus, consists, as will be well known to most of our members, of a network of anastomosing and transparent tubes. These tubes, containing protoplasm, are divided by septa at rare intervals into elongated cells. The septa become more frequent at the points where sori are formed, and, in *Uromyces pisi* and other species producing spores of that colour, orange granules appear in the protoplasm.—J. W. R.

alight on the Euphorbia leaves germinate, enter the tissues, and, in course of time, produce the æcidiospores. The secondary spores produced by the teleutospores germinate only on the Euphorbia and not on the pea, whereas the æcidiospores formed on the Euphorbia germinate only on the pea.

"*Distribution.*—Italy, Sicily, France, Switzerland, Austria, Belgium, Germany, Bohemia, Finland, and Asiatic Siberia. It is fortunately rare in Britain, as the Euphorbia is not a native. The Euphorbia, however, is not uncommon as an ornamental plant in cottage gardens.

"To effect a cure for this disease, it is only necessary to remove from the vicinity one of the two host-plants essential to its existence."

As just mentioned, the mycelium in the Euphorbia goes on producing the æcidia as long as the host lives. It not only does this, but, by the use of suitable reagents, such as caustic potash, can be seen penetrating almost every part of the plant, descending mainly by its vessels. During the winter, when the Euphorbia dies down, the mycelium hibernates in the rhizome.

The life-history of *Uromyces pisi* exhibits the maximum number of known spore relations, which is five; one or more being suppressed in some species. We have the pro-mycelial spore, the spermogonium, the æcidiospore, the uredospore, and the teleutospore.

The spermogonia are generally formed below the upper surface of the leaf bearing the æcidia, and are developed from the same mycelium. Sometimes, however, they occur on the lower surface, and in several of my sections they are shown thus in juxtaposition with the æcidia. These flask-like growths in the sub-cortical tissue, with brushes of hair-like filaments at their projecting apices, pour out at maturity vast numbers of spermatia—extremely minute bodies resembling spores—which have been held by some to be the male sexual element. There seems, however, to be a consensus of opinion, amongst fungologists, that there is not sufficient warrant for this idea. The spermatia are associated with a viscid fluid; and Dr. Cooke, in the fourth edition of his "Rust, Smut, Mildew, and Mould," published in 1878, says that the largest examined up to that time were only the $\frac{1}{2500}$ of an inch in length and the $\frac{1}{100000}$ of an inch in

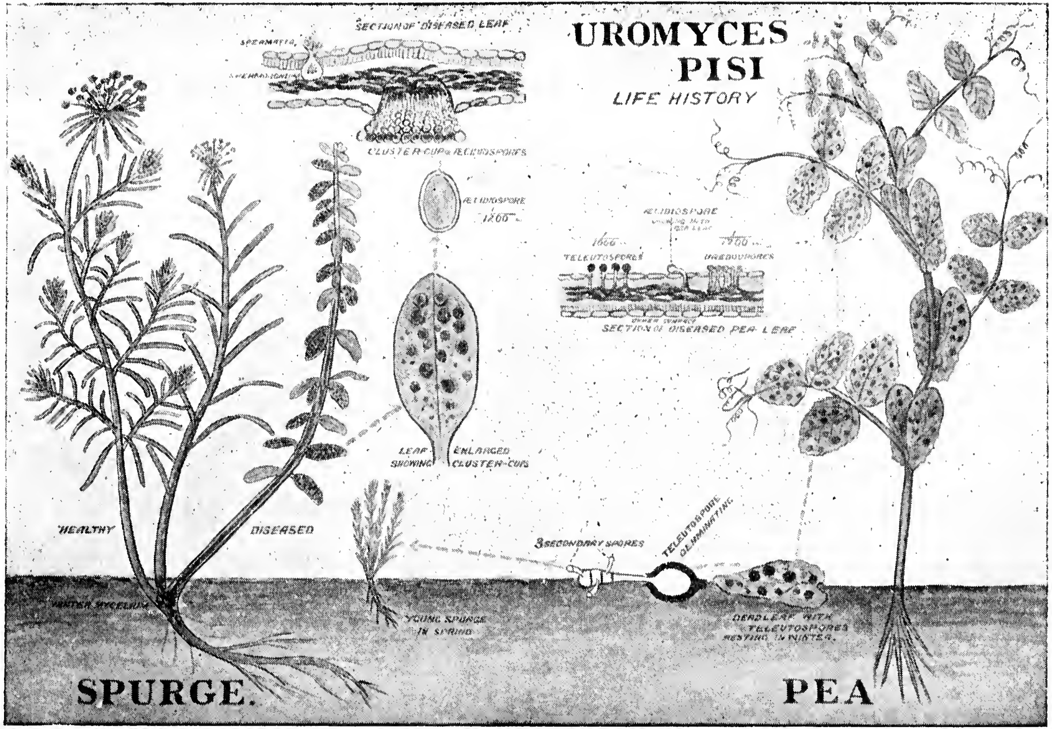


Diagram showing infected plants of Spurge (Euphorbia) and Pea, and sections of leaves with æcidia and sori of uredo and teleutospores. The passage of an æcidiospore from the spurge to the pea leaf, the germination of a teleutospore, producing secondary spores, and the inoculation of the young spurge by these secondary spores, are roughly indicated.

width. Up to the present, their function is not known; but it is difficult to believe that they have none, unless indeed they are merely a survival of structures which were useful under conditions that have long since passed away. This is probably true in most instances, but spermatia of some species have been caused to germinate and produce a mycelium like that of the uredo condition of the fungus.

Sometimes the spermogonia occur in conjunction with the uredospores, and sometimes in conjunction with the teleutospores, though this latter is apparently not the case in the genus Uromyces.

The æcidiospores are produced in basipetal chains, the oldest spores being at the apex of the chain, the youngest at the base: they are from 17 to 20 μ (say the $\frac{1}{1250}$ of an inch) in diameter. As the terminal spores mature they become free and form an orange powder, which fills the whitish-edged and slightly fringed cluster-cup. They are, at maturity, globular or polygonal, and roughened on the outer surface. The walls are thinner in certain places, and it is through these so-called germ-pores—and as a rule from only one—that the germ-tube issues. It is these germ-tubes which, finding their way through the stomata of the host-leaf, start densely woven mycelial growths in the intercellular spaces of its tissue. The mycelial tubes not infrequently develop tubular suckers, called Haustoria, which penetrate the cells themselves, abstracting their manufactured food-stuffs for the benefit of the parasite.

It is noted in Plowright's monograph that "Mr. G. Massee considers the whole æcidium to be a sexual product resulting from the conjugation of two dilated mycelial hyphæ in the tissues of the host-plant." This theory of Mr. Massee has not as yet been corroborated. The preparations, on the examination of which it was founded, were handed to De Bary whilst on a visit to England, and he took them back with him to Germany for further investigation. Unfortunately, in the confusion arising from the sudden death of the Professor, the preparations were lost.

The mycelium present in the leaves of the host-plant (*i.e.* the pea) resulting from inoculation by the æcidiospores, as described above, gives origin to the first crop of uredospores, which are produced singly at the tips of short branches of the mycelium. The epidermis is ruptured, and they appear on the surface as

orange-coloured patches or sori. The uredospores thus formed germinate on other pea-leaves, and produce successive crops of uredospores throughout the summer; and finally, in the autumn, the same mycelium produces a crop of teleutospores, which form dark brown sori on the surface of the leaf, and these, as said before, rest during the winter either in the soil or on the surface in connection with the decayed leaves, producing in the spring the pro-mycelial spores which inoculate the newly developed foliage of the Spurge.

The uredospores are spiny, of a yellowish brown, and 17—21 μ (say the $\frac{1}{1250}$ of an inch) in diameter. They are said to have as many as six germ-pores, and never less than two. The germination and mode of attack on the host-plant are the same as in the case of the æcidiospores.

The teleutospores, darker in colour than the other forms, are produced in all Uredineæ, and generally at their period of decay. No fully satisfactory explanation as to the causes which determine their production at this period has yet been offered. In some species this is the only form of spore known. They are unicellular in *U. pisi*, this being the invariable rule in the genus; and there is not more than one spore developed at the end of each pedicel. They are 28—30 × 17—20 μ (say the $\frac{1}{800}$ of an inch in their long diameter by $\frac{1}{1250}$ of an inch in their shorter one). The teleutospores of all Puccinias are bi-cellular, and their structure is most clearly displayed in two beautiful slides of *P. arundinacea* and *P. amorphæ* lent me for this occasion by Mr. Massee.

At the apex of the teleutospore there is a single perforation only, or at any rate a thinning of the outer cell-wall which looks like it, and it is through this that the germinating process protrudes; in other words, the exospore is pierced by the endospore in germination. When the teleutospores are bi-cellular the germ pore of the lower cell occurs just below the median septum. This perforation, if it be such, is shown in one of the slides under the microscopes. A section on the same slide shows other accidental and very dark globose bodies, which must not be confused with any stage of the Uromyces; they are specimens of that very cosmopolitan fungus *Sphærotheca Castagnei*, or hop mildew.

The germ tube of the teleutospore does not form a mycelium,

but is broken up near the apex into three or four short cells, due to the formation of transverse septa. Each cell gives origin to a very slender outgrowth or sterigma, the apex of which eventually bears a pro-mycelial spore, capable of producing a mycelium. These spores Mr. Massee has spoken of as Sporidiola or secondary spores.

The best way to start the germination of spores is in a hanging drop of cold water containing 1 per cent. of cane sugar. The best medium for mounting them is glycerine jelly, the spores being first soaked in glacial acetic acid, to prevent shrinkage.

Such, in brief, is the life-history of the Fungus the presence of whose æcidial stage effects such a transformation in the stem, foliage, and habit of the *Euphorbia Cyparissias.* I am only too conscious that my part of the present contribution to the study of this particular parasitic fungus is of a very elementary nature; but a romance of plant life is involved which I venture to regard as of absorbing interest. It only remains for me to hope that, by thus bringing before you this small item from our botanical collections in the Valaisian Alps, more competent members than myself may be led to investigations in a field which promises a further rich harvest of discoveries at once valuable and even startling.

Reference to figures on Plate 6.

Fig. 1. Healthy plant of *E. Cyparissias.*
Fig. 2. Diseased plant of *E. Cyparissias.*
Fig. 3. Enlarged leaf of *E. Cyparissias*, with æcidia.
Fig. 4. Section through leaf and æcidium.
Fig. 5. Æcidiospore of *Uromyces pisi.*

On Two New Rotifers.

By J. E. Lord, Rawtenstall.

Communicated by D. Bryce.

(*Read April 15th*, 1898.)

Plate 7.

1. *Taphrocampa nitida*, sp. nov.

Sp. ch.—Body plump, cylindrical; brain clear; a decurved frontal hood; eyes two, pale; an inconspicuous tail; foot and toes small, somewhat ventrally placed.

For many years the author was an almost daily student of the Rotifera of the Rossendale district; regular "fishing" excursions were made to a limited number of ponds, and notes were taken of the gatherings. So systematically and well was the district worked that the finding of an unfamiliar Rotiferon was a very exceptional occurrence. Circumstances have prevented my doing any microscopical work for over six years; and on resumption, a few weeks ago, the remarkable thing is that a very considerable number of the Rotifera captured are species that never occurred to me in my former close study of the class. From this it would appear that there may be a gradual though material change taking place in the Micro-Fauna, and presumably in the Micro-Flora of various waters, even where there is no appreciable alteration in the conditions—a point which, so far as I am aware, has not previously received recognition.

From a pond rich in Micro-Algæ, and which has afforded me many unusual forms of the Rotifera, I collected this new Taphrocampa. In this species, which is plump and grub-like, there are not so many rings as in the three other recorded species. I could never make out more than five or six, and what I may term the internodes were convex rather than concave; indeed, the annulation in this form is not nearly so prominent a character as in the

others, but is unmistakable on close study. The head is rounded, with a frontal hood not differing from *T. Saundersiæ*, and when seen in front view, a position which does not frequently present itself, the two pale but unmistakable eyes show prettily through the base of the transparent hood, being situated in front of the brain. The ciliated face is rounded and somewhat prone, with only feeble ciliary action. The mastax is no larger—I believe smaller—than the brain; and the trophi, which are of the forcipate type, do not nearly fill up the bulb, in which they seem to hang very loosely. They are moved in a very jerky way by the muscles of attachment, and, as in the other species, can be brought to the very front of the prone face. When the animal is fully extended a slender œsophagus of moderate length is seen to connect the mastax and stomach. Under the same conditions of extension there is a distinct neck behind the globose head, and the anterior thread-like muscles are well displayed. The stomach in my specimens was ample, and full of bright green and brown food particles; the intestine was about the same size as the stomach; the ovary ordinary in type and position. Neither lateral canals nor vibratile tags were detected, nor were there any indications of auricles; though, as the integument was of almost glassy transparency, these details ought to have been visible if present. I also failed to detect either salivary or gastric glands. The tail can hardly be said to project beyond the posterior, truncated part of the body; but, as the anus is situated between a loose fold of the skin and the foot, it is technically a tail. Foot bulb and toes very small, and placed somewhat ventrally. I have little to communicate as to the habits and manners of the species; I never saw it swim, and should imagine its natatory powers are of the feeblest description. The body was often violently contracted, and it had the peculiar grub-like habit of bending its anterior and posterior parts simultaneously, first ventrally and then dorsally. Length, at characteristic extension, about $\frac{1}{150}$ of an inch.

Habitat.—Pond in Rossendale.

Since the foregoing was written, Mr. Bryce has been kind enough to send me a translation from Bergendal's "Rotifera of Greenland," in which occurs a description of a new Taphrocampa, which he names *T. Levenseni.* This species is certainly very different from my *T. nitida*, and, as the author points out, stands nearly midway between *T. annulosa* and *T. Saundersiæ.* It has

the chalky brain-mass and cervical eye of *T. annulosa* and *T. selenura*, which are not present in my *T. nitida*. In fact, the three forms *T. annulosa*, *T. selenura*, and *T. Levenseni* show strong evidences of their notommatous relationship, while my *T. nitida* is evidently an annectant form with Gosse's genus *Proales*. There are still two newly described species with the characters of which I am unacquainted—viz. *T. viscosa* of Levander and *T. clavigera* of Stokes. Judging from the specific names, one would be inclined to say that they represent species different from *T. nitida*.

2. *Callidina cataracta*, sp. nov.

Sp. char.—Trunk brown; integument leathery, minutely shagreened and slightly viscid; 14 strongly marked longitudinal ridges, the 4 central ones not parallel; the 2 anterior central ones approximate, and then diverge to about the beginning of the second central segment, where they are connected with the next pair by a transverse fold; posteriorly they are broken up and connected by several cross-folds, so as to form a parquet-like pattern; with 4 anterior spines, 2 medio-dorsal, and 2 lateral; anterior ventral margin, with a central curved excavation; 8 rough spines, with acuminate points in a single transverse row, just behind the middle line, following which is a deep, rounded depression; corona (0·070 mm.) wider than neck (0·050 mm.), with a rather deep, square sulcus (0·016 mm.); foot of 5 segments; antenna long (0·030 mm.); spurs small (0·009 mm.) and conical, slightly separated at base; toes 4, in 2 unequal pairs; rami formula 2/2. Length from $\frac{1}{70}$ to $\frac{1}{60}$ of an inch (0·350 mm.).

In recent years the additions to the genus Callidina have been very numerous. In Hudson and Gosse's monograph only ten species were admitted; but since that time, through the labours of several Continental microscopists and one or two indefatigable members of the Quekett Club, the number has been brought up to 34; and I here describe another of the spinous forms of the genus. It is very close to *C. alpium*, but still nearer to a spinous form found near Geneva by Dr. Weber. Indeed, it has only been by a further study of drawings of the latter, kindly lent to him by Dr. Weber, that Mr. Bryce has been enabled to separate them, and he now considers them distinct species. As I understand that Dr. Weber has now published his work on the Bdelloidæ,

microscopists will be in a position to compare the forms. It will, however, be advisable to characterise my *C. cataracta* rather more fully than is usually necessary.

About three miles from my residence, in a narrow gorge, there are some almost perpendicular rocks, from 80 to 90 ft. in height, down which flow, at several points, considerable streams of water. Here the rocks are covered with golden saxifrage, mosses, and confervoid Algæ, and it is chiefly from the latter that I procure the new Callidina. It is one of the larger forms of the Bdelloida and very Philodina-like; indeed, I at first took it, or rather mistook it for *P. aculeata*, but a short examination proved that it could not be that Rotiferon, and as there are no eyes, it is technically a Callidina. It is an extremely sluggish animal,—it may be under observation for hours without everting either its anterior or posterior parts, and these may be exserted for a similar period, and yet no disposition be shown to evert the corona. However, on being kept in confinement for a day or two, some of this shyness disappears, and it then feeds with tolerable freedom. From several observations made under these favourable conditions, I am able to say that in feeding, the foot is fairly extended, but the neck is much retracted—so much so that very frequently the antenna is protruded between the two medio-dorsal spines, exactly as in Brachionus. The lobes of the corona are wider than the neck; there is a rather deep, square sulcus between them, and a considerable thickening of the neck immediately below. The antenna was two-jointed, slender, and about as long as the width of the neck at its juncture with the trunk, and set with diverging setæ at the tip. The foot was rather long and tapering, at full extension of, I think, 5 joints, although at times it is difficult to see more than 4. The spurs are small and conical, with a quite perceptible interval between them. The toes are very seldom everted, and then as usual instantly covered by the penultimate segment of the foot; but there were 4 toes, in two unequal pairs, each pierced by several pores. The most striking peculiarities, however, were in the trunk, and by these it may the most easily be recognised when seen. This was brownish, the integument of thick, leathery texture, with 14 longitudinal ridges, the 8 dorsal ones acute and strongly marked, the latero-ventral ones fainter, the outer pair occasionally very indistinct. The four central ridges are not

parallel, like the others; but anteriorly the two central ones approach each other, and then diverge to about the juncture of the first and second central segments, where they are connected to each other and the next pair by a transverse skin-fold; posterior to the dorsal spines these 4 ridges are broken up and connected by cross folds in such a manner as to form a sort of parquet-like pattern. On the ventral aspect these ridges are absent, but there are faint indications of transverse plications. On the anterior dorsal edge there are two conical spines close together, with their apices forwards; and on the extreme lateral edge, but just below the anterior margin, there are two low spines, which, on the extension of the animal, are at right angles to the body; and between each pair of ridges there are prominences, more or less marked, which vary considerably in different individuals, sometimes almost approaching spines in character. The anterior ventral edge is excavated in a curved manner, and one or even two pairs of low spines may sometimes be seen on the shoulders, in a line with the lateral spines, and like them, below the anterior edge, and at right angles to the ridges; but these are, I believe, only temporary. I have seen individuals entirely without them, while perhaps the next had either one or two pairs. Just behind the median line there is a transverse row of 8 strong, rough spines, with acuminate points, diminishing somewhat in size as they approach the sides; occasionally an extra pair may be visible, and as I saw several specimens with this extra pair, I was led in the first instance to describe the species as having ten spines in the row, but they are only temporary, and may be seen gradually to melt away upon the extension of the animal. Indeed, the formation of these temporary spines seems to be a peculiarity of this species, and may readily lead to error. I have seen a specimen with a complete row of these spines anterior to the permanent ones, another with spines posterior to them; but in both cases they vanished while under observation. The fact is, that, owing to the thickness of the integument and the acuteness of the ridges, these temporary spines are liable to be formed on any part of the trunk, whenever contraction takes place. The spines are on the ridges, and are indeed a continuation of them, as may readily be seen either on a dorsal, but especially on a lateral view. Immediately behind the spines there is a deep rounded

depression, highly characteristic of the species. The internal organs are, I presume, normal, but the character of the integument precludes any close study of details; it was just possible to see that the jaws had two teeth, and that in the foot were two well-developed glands and ducts. I was unable to obtain any very exact measurements,* but on extension the animal will be from $\frac{1}{70}$ to $\frac{1}{60}$ of an inch in length.

Habitat.—Confervoid Algæ on dripping rocks, Rossendale.

Explanation of Plate 7.

Fig. 1*a*. *Taphrocampa nitida*, lateral view.
,, 1*b*. ,, ,, front view of head, showing hood and eyes.
,, 1*c*. ,, ,, mastax and jaws.
,, 2*a*. *Callidina cataracta*, lateral view.
,, 2*b*. ,, ,, dorsal view.

* The measurements in brackets have been kindly supplied by Mr. Bryce.

On Diatom Structure.

By Edward M. Nelson, P.R.M.S.

(*Read May 20th*, 1898.)

Plate 8.

As time progresses fresh discoveries in diatom structures become more difficult, for the simple reason that the larger or coarser structures have all been described long ago, and only the finer and more delicate ones are left. Among these, however, there is a good deal yet to be done, even with our present appliances, and when further optical improvements are effected there will be a great deal more to do. For of this we may be certain, that microscopes have by no means exhausted the details of diatom structure, any more than telescopes have exhausted the details of the solar system.

The first object to be recorded this evening is a variation of *Coscinodiscus Asteromphalus* (Fig. 1, Pl. 8). Instead of the well-known pattern consisting of a ring of larger areolations surrounding the finely perforated membrane which covers a large polygonal cell, we have a circular ring of brackets projecting inwards to strengthen this delicate membrane or cover. The perforations in the centre of this membrane are excessively minute, and those round it are far more minute than those in an ordinary *Asteromphalus.* These brackets are very similar in appearance to those supporting the delicate auditory membrane in the pygidium of a flea.

The second point to record is the discovery of a tertiary structure in an *Asteromphalus* of the common form (Fig. 8, Pl. 8).

This tertiary structure must be looked for in the interior of those secondaries which encircle the finely perforated membrane. It is hardly necessary to say that these tertiaries are excessively minute. In form they are not unlike the secondaries of *Asterolampra vulgaris*, admirably figured by Mr. Karop in Fig. 10, Pl. 4, Ser. 2, Vol. 3, p. 41 (1887).

This is a difficult image, not only on account of its minuteness, but because of its liability to be merely an interference image. There are certain minute microscopic images which, although difficult to see, are nevertheless undoubtedly true, for by no known method could they have been caused by interference. There are, on the other hand, some comparatively large microscopic images, which are so likely to have been caused by interference, that, apart from some special proof, they cannot be regarded as true. The *Systephania diadema* = *Stephanopyxis corona*, Fig. 4, Pl. 20, Vol. 4, Ser. 2, p. 316, may be cited as an example of this latter class of object. There the structure, comparatively coarse, is one that is in all respects very similar to an interference image—so much so that for long I regarded it as such; but further search revealed a broken piece with some of the supposed ghost structures sticking over the edge, which proved the image to be unquestionably a true one. In the case now before us, however, its very minuteness prevents this test being applied, for it would be quite impossible to see at a fractured edge such a structure, even though it were several degrees coarser.

In microscopical images all fractures and edges are bounded by an umbra, coma, or undefined margin. This umbra tends to blot out all finer structures in its immediate vicinity. Thus the umbra of a primary blots out (either partially or wholly) the image of the secondary; much more, therefore, would it blot out a tertiary. For example, the postage stamp fracture in a *Triceratium favus* is not so easily seen as it might be on account of the umbra of the large primary structure. On the other hand there is no similar difficulty found with the postage stamp fracture of a *P. angulatum* or a *N. rhomboides*, for there is no coarser primary present.

It is obvious, therefore, that we must resort to some test of truth other than that of a fractured edge. Let us, therefore, try counting the number of spots in each aperture, for if they are ghosts they will be replicas of some pattern—*e.g.* six spots surrounding a central one. This, though a difficult operation, has been done, and both a five and a four have been seen, and sometimes the central one has been found wanting; further, these observations have been confirmed by an independent observer; therefore we may conclude that the image is not that of a ghost, but an indication of an actual structure.

If further evidence be required, it may be remarked that six spots with a central dot is the interference image or ghost of a quincunx pattern. Now, the images in question cannot possibly be interference images of the quincunx pattern of the primary polygonal structure of the valve, because the position of the intercostal ghosts would be in the intercostal areas; again, as a *dernier ressort*, it may be said that it is an interference ghost of the thirteen (more or less) spots at the periphery of the cell cap: to this it may be replied that any one making such a statement is bound to prove that the interference ghost image of thirteen (more or less) spots in a circle is the same as that of a quincunx pattern; which of course could not be done. The crushing argument is, however, this: viz., that there are structures precisely similar in every respect, both as as to size and arrangement of spots, etc., which do not possess this tertiary structure. The tertiaries cannot, therefore, be interference effects arising from the primary or secondary structures, otherwise they would be seen in all cases where the conditions were similar. This brings down the matter to two points: viz., that this tertiary structure is what it appears, or is an interference ghost of some as yet undiscovered quincunx membrane inside the polygonal cell. Against this latter supposition we have the dissimilarity in the patterns and number of tertiary spots. Fig. 3, Pl. 8, is drawn from another diatom to show irregularity in pattern. There are, it will be noticed, six, five, four, and three dots round a very faint and ill-defined central spot. This central spot may or may not be an out-of-focus image of the eye spot on the lower membrane; anyhow, this is of no importance, for the argument rests on the peripheral dots. No one will contend for a moment that such an irregular pattern is merely an interference effect, and not the image of an entity; its very irregularity negatives the idea. Moreover, it should be noted that this is a coarse structure.

Now, with regard to the meaning of this tertiary structure, my theory is that it is a stage in the evolution of the central perforated membrane; the large spots at the periphery become divided up and thrown into the central portion, while other large ones are formed to be broken up in their turn until the valve has reached its adult size.

Fig. 7, Pl. 8, shows this going on, for we have the large peripheral secondaries breaking into two dots, and the two dots thus formed

becoming an integral portion of the central perforated membrane. You will notice that the large peripheral secondaries are in all stages; some are only just beginning to notch, others more advanced are nearly cut in two.

That something of this kind takes place, the figures in Pl. 18, Vol. 3, Ser. 2, p. 201 (1888), in illustration of my paper on the "Formation of Diatom Structure," go to prove; further, Figs. 2, 4 and 9, Pl. 8, and Fig. 2, Pl. 20, Vol. 4, Ser. 2, p. 316 (1891), illustrate the same thing, and are especially interesting because they are the first stages in the formation of the delicate perforated cap of the *Asteromphalus*; these may be found forming a graduated series from the elementary triangle up to the *Asteromphalus* pattern, as generally known, and as figured by Mr. Karop in Fig. 1, Pl. 17, Vol. 2, Ser. 2, p. 270 (1886).

The evolution of the peripheral dots from the triangle is interesting. I am now able to give a more complete account of this, owing to the discovery of some intermediate forms since my previous paper was written in 1891.

In the first instance, for a *terminus ad quem*, we have merely the plain polygonal (practically speaking hexagonal) structure with the usual eye-spot layer attached. Next we find an equilateral triangle at each intercostal, the apices of the triangle pointing to the centre of the hexagons, and the sides of the triangle cutting the sides of the hexagon at right angles (Fig. 2, Pl. 8). Next we find the triangle growing larger and the apices of it becoming blunted. Next a large dot is formed between the parallel sides of two adjacent triangles at a point about half way between the intercostal points. By this means six large perforations are formed in each hexagon, not at the angles of the hexagon, but at the bisection of its sides (Fig. 9, Pl. 8). About this period the blunted apices of the triangle become notched, the notches deepen, and eventually become perforations. These perforations, which are at the intercostal angles, are not so large as those at the bisection of the sides of the hexagon. At this point, then, we have twelve perforations round each hexagon, six large ones at the bisection of its sides, and six small ones at the intercostal angles. At the next step the small intercostal perforations become elongated, then notched, and eventually divide into two. The microscopical resolution of these is precisely similar to the splitting of close double stars with a telescope

(Fig. 6, Pl. 8). Up to this point we have not had any trace of the finely perforated central membrane, but now it begins to appear round those intercostal spots which have divided. Fig. 5, Pl. 8 shows this stage, and the suggestion I offer is that the minute perforations in the central portion are formed by the breaking up of the six peripheral intercostal dots. Thus far in no case has the large dot at the bisection of the side of the hexagon been seen to break up: the activity is confined solely to the intercostal dots; in short, it is from the intercostal point that the whole secondary structure originates. This brings us to what has been considered as the mature Asteromphalus pattern, a number of large perforations, more or less similar in size, surrounding a finely perforated sieve-like membrane, the whole forming a cap to the primary polygonal structure. The discovery of the new tertiary structure would seem to show that the ordinary *Asteromphalus* is not the *terminus a quo* of this diatom, but that after a time the whole of the peripheral dots, those at the bisections of the sides as well as those at the intercostal angles, break up and form an extended perforated membrane. By this means the intercostal silex becomes so reduced that the operation need only be repeated two or three times, when a uniformly perforated membrane will be formed over the whole of the valve. Diatoms of this form do exist: may they not be regarded as the final forms, while the common *Asteromphalus* is merely a stage in their evolution?

The following is an enumeration of the steps in the evolution :—

1st. A small equilateral triangle is formed at the intercostal junction of the polygonal cells (Fig. 2).

2nd. The angles of the triangle become blunted.

3rd. The blunted end becomes notched (Fig. 4).

4th. The notches deepen, and eventually becoming circular, form a perforation at each intercostal angle. At the same time the sides of the triangles form a larger perforation between them. These larger perforations are situated at the bisection of the sides of the hexagons (Fig. 9).

5th. The peripheral perforations situated at the intercostal angles break into two, and by repeated subdivisions form the central finely perforated membrane (Figs. 6 and 7).

6th. The peripheral perforations, when the central membrane is complete, become more or less of a uniform size, and then break up into tertiaries (Fig. 8).

7th. Repetitions of the sixth process produce a uniform and delicate perforated membrane over the whole of the valve.

Beyond the sixth we cannot with certainty go, for we have no evidence concerning the seventh or final stage. The sixth stage may be the last, or it may go on repeating itself, after the manner of the fifth, until there is formed, not merely a cap to each polygonal cell, but a complete membrane covering the whole surface of the valve; and further, may not this be the adult form of the valve?

I have frequently seen such valves: they consist of a primary honeycomb structure, with an eye-spot layer below it precisely similar to an *Asteromphalus*, but having, in place of the well-known caps to the cells, a delicately perforated membrane extending over the whole surface of the valve. The suggestion (merely a suggestion, for I am quite unable to prove it) I now throw out is that a valve consisting of polygonal primaries entirely covered with a uniform and delicately perforated membrane is the adult form of the diatom known as *Coscinodiscus Asteromphalus*, and that this is formed by the continual repetition of the seventh stage.

All who have conscientiously worked at these images will, I believe, admit that all the stages up to the sixth are proved. With regard to the last, it may be left *sub judice* until further evidence is forthcoming. In conclusion, let me say that the diatoms were from the Nottingham deposit, and the slide was kindly given to me by Mr. Ingpen. All the stages up to the fifth inclusive have been observed in many different mounts, but the sixth has only been seen in Mr. Ingpen's slide, and another old slide mounted by Möller: probably careful search would reveal the structure in almost any slide containing Nottingham *Coscinodisci*.

Let us in conclusion hark back for a moment to our first step. It would be very interesting to learn what was really the *terminus ad quem* of this species. Is it the primary polygonal structure, or the eye-spot layer; or is the eye-spot layer formed out of the polygonal structure, or *vice versâ*? As there is nothing particularly minute about these structures, it ought not to be difficult to find an answer to these questions.

In these Nottingham slides there are examples of a diatom which possesses large circular primaries with broad intervening silex. Very similar valves are also seen having a larger number of primaries and consequently narrower intervening silex; others

have a still larger number, and so on until we find the circular primaries compressed into hexagons. It is important to note that this compression into hexagons commences at the periphery of the valve, the last primaries to retain the circular form being situated at the centre of the valve. This is strictly in accordance with the law of diatomic growth I have previously enunciated,* viz., mature at the periphery, immature at the centre.

Although these forms have specific names allotted to them, I regard them as being early stages in the evolution of the *Asteromphalus*.

With regard to the eye-spot layer, it is altogether absent in the first stages, but makes its appearance when the primaries assume their hexagonal or polygonal shape. The *terminus ad quem* may be said to be a circular plate of silex sparsely perforated with circular primaries.

* Q.M.C. Journ., Vol. 3, Ser. 2, pp. 201 and 308 (1888).

On Orbiculina Adunca (Fichtel and Moll) and its Varieties.

By A. Earland.

(*Read June 17th*, 1898.)

A few months ago Mr. Karop very kindly placed me in communication with Mr. D. Bryce Scott, a member of this Club residing abroad, from whom I subsequently received a quantity of dredged sand from a West Indian locality, of the exact particulars of which I am at present in ignorance. The material proved upon examination to be a very typical Coral Sand, presenting no special feature in its fauna, but of great interest, owing to the abundance of one species: viz., *Orbiculina adunca* of Fichtel and Moll. This foram occurs in great numbers, and I do not think I should be far out in estimating that quite one-quarter of the entire bulk of the material is made up of this species in a more or less perfect condition. Orbiculina is notoriously subject to great variation in shape and size; indeed, since the species was first described by Fichtel and Moll, in the year 1803, the numerous varieties have been figured and described by various authors under about fifteen synonyms. I have succeeded in obtaining a very complete series of the varieties from Mr. Scott's material, and with your permission I will now attempt to give you a short account of the life history of this foram, so far as it can be gathered from the study of the dead shells, and to illustrate by means of rough diagrams the method in which these protean shapes arise.

The genus Orbiculina, which consists of a single species only, the foram now under consideration, belongs to the Imperforate Foraminifera, in which the shell is entirely destitute of foramina or apertures in the shell wall for the emission of the pseudopodia. It is now located in the sub-family Peneroplidinæ of the family Miliolidæ, the members of which are characterised by shells of a porcellanous whiteness when viewed by direct light, turning to a

light amber brown when examined by transmitted light or in transparent sections. Owing to the absence of foramina throughout the family to which I have already alluded, the only means of communication with its surroundings which the animal possesses is through the oral aperture at the extremity of the latest formed portion of the shell. Through this opening the sarcode body of the foram exudes in its search for nutriment, and I shall try and demonstrate that the nature and position of the aperture, which differ in the several genera, exercise a considerable influence in the growth of the shell. Orbiculina, in common with Peneroplis and a few other Miliolidæ, frequently presents a pitted appearance under the microscope, but it can be easily shown by means of sections that these depressions are merely superficial markings, and are not continuous through the entire thickness of the shell wall.

The family of the Peneroplidinæ consists of four genera only, and as these four are a very complete series displaying a gradually increasing complexity of structure, I propose in a few words to describe the generic features of the less complex forms before touching Orbiculina. The first genus and the simplest in structure is Cornuspira, founded by Schultze in 1854. It contains those Imperforate Foraminifera in which the sarcode body is contained is a simple porcellanous tube without internal divisions or septa, and coiled upon itself in one plane. The only aperture for the emission of the sarcode is the open end of the tube, which is sometimes slightly constricted. Now this, as you will see, is a very simple and elementary form of shell, and as such might be expected to have a considerable range both in time and distribution. Such is actually the case, for it ranges from the Lias to the present day, having now a world-wide distribution from the shore line to nearly 2000 fathoms.

The next genus, Peneroplis, shows a marked advance in complexity of structure. Starting, as usual, with a primordial chamber, it continues its growth by means of a succession of segments which are arranged in a more or less spiral manner in one plane. The interior cavities of these segments are entire—that is to say, they are not subdivided into chamberlets by internal partitions. The aperture for the emission of the sarcode consists of a more or less regular and sieve-like series of openings on the outer face of the last formed segment. The above are the only

features which can be considered common to all the specimens of this genus, which is subject to the widest variation in every minor feature. To such an extent is this the case that the single species to which the genus is now restricted has at one time or another been described under about fifty different names.

The third genus is the subject of my note, Orbiculina, and as with Peneroplis, the genus contains but a single species. Briefly Orbiculina may be described as a Peneroplis in which the segments are subdivided into chamberlets by the formation of internal septa or partition walls. Typically it is a planospiral porcellanous shell, starting from an original primordial chamber, the successive segments being spirally arranged, and the first few convolutions being usually more or less embracing or nautiloid in shape.

This nautiloid form, although generally constant in the early stages of the foram, does not as a rule continue after the test has reached a certain size, and the variation which then sets in is liable to modification in two different directions. On the one hand the successive segments, increasing very slowly in size and length, depart from the original spiral arrangement, and form a more or less curved linear series of chambers, attaining in extreme cases a crosier-shaped test which is akin to the Spiroline varieties of Peneroplis. On the other hand, the chamberlets in the successive segments may increase so rapidly in size, especially in length, that each successive segment will considerably overlap its predecessor. The result of this mode of growth is that in time the later segments completely encircle the earlier ones, and the foram assumes at first an ellipsoidal and finally a perfectly discoidal shape, with a ring of oral apertures completely encircling the margin. The method of growth now continues annular, and the specimen resembles an Orbitolites except for the fact that the nautiloid early chambers are nearly always distinguishable as a convexity in the central region of the disc.

Now the most striking feature noticeable in the examination of the large number of specimens which has come under my observation is the great disproportion in size and robustness of growth which exists between the crosier-shaped and the discoidal varieties. As will be seen from the specimens under the microscope, the crosier-shaped variety is less than $\frac{1}{10}$ of an inch in length, while discoidal specimens $\frac{1}{4}$ inch in diameter are comparatively frequent.

There must be a reason for this difference, and it appears to me to be due to the condition and vigour of the animal when it reaches that point in its life at which it becomes necessary to abandon the nautiloid method of growth. The oral aperture in Orbiculina, as in Peneroplis, consists of a series of openings, more or less sieve-like in appearance, situated on the front of the last formed segment. Now, as these openings are the only means by which the sarcode body of the animal has access to the surrounding water and ooze, from which it derives not only its food but also the supply of carbonate of lime for the construction of its shell, it follows that the greater the surface covered with these oral apertures, the larger the supply of food and building material obtainable, and consequently the more vigorous the after-growth of the animal. Even in the nautiloid early stages it is evident that there is some difficulty in obtaining a sufficient supply of nutriment from the limited area of apertures open to the sarcode, for there is a constant tendency to extend the oral surface by elongating the V-shaped surface of the final segment in a backward curve. No doubt a point is eventually reached when it is impossible to obtain an adequate supply of nutriment to maintain this method of growth, and the variation then commences. The stronger and more vigorous specimens, being able to build more rapidly and to extend their segments over a longer front, enlarge their feeding area immensely, and so obtain increased vigour and building power, eventually attaining the discoidal form, in which they may be said to have mouths all round them. On the other hand, those individuals which are hampered at the start by weakness and an inability to increase their feeding area continue to grow in a weakly manner, and form the crosier-shaped forms.

I do not know whether any student of the Foraminifera has ever put forward this theory of growth to account for the variation of form among the Peneroplidinæ, but it appears to me to obtain additional force from the occurrence of certain aberrant and monstrous varieties which are to be found among discoidal specimens. When an Orbiculina has reached the discoidal shape accompanied by its annular method of growth, it is evident that it can only increase its area of oral apertures by continuing its growth in a fresh plane. Hence in some specimens we observe what we may describe as flanges of segments thrown off at various

angles from the parent disc, and occasionally these flanges become so numerous that the original disc can only be traced with difficulty.

In the fourth and final genus of the subfamily, Orbitolites, the arrangement of the chamberlets attains a still more complex form; but it lies outside the scope of this paper, inasmuch as the crosier form is confined to the earliest stages of certain species only, and the adult shells are all normally discoidal. The desired increase in the area of the oral apertures is also obtained in a different manner by means of subsidiary chamberlets, the arrangement of which was very fully described by the late Dr. Carpenter.

On some Micro-Cements for Fluid Cells.

By Charles F. Rousselet, F.R.M.S.

(*Read June 17th*, 1898.)

Three years ago I read before you a short note on Clark's Spirit-proof Micro-Cement, which had proved reliable for many years in securely sealing micro cells containing methylated spirit. I then recommended this same cement for cells containing watery fluids. It appears, however, that I too hastily jumped to the conclusion that, because this cement is good for spirit mounts, it would also be equally good for watery fluids, a conclusion which seems natural enough. After three years' experience I must pronounce it a complete failure as regards watery fluid mounts, while the spirit mounts remain as good as before; and I hasten to communicate these facts, so that others may profit by my experience.

The possession of a thoroughly good and reliable cement for fluid, and especially watery fluid mounts, is so important to microscopists, that I hope all members of the Club who have any special knowledge and experience in this direction will communicate their experience for the benefit of all. Owing to the failure of the cement to keep in the water, I have had to remount over three hundred slides of Rotifers, which is no small work, attended with considerable risk of losing the objects. I have a few deep cells filled with fluid which have kept very well for four or five years, but it appears the greatest difficulty is met with in small shallow cells, which contain only a fraction of a drop of water.

I have, of course, continued my search for a cement which will absolutely prevent the evaporation of water. It seems that all cements containing solid particles become porous, or at least slightly pervious to watery vapour, when once quite dry, and therefore it appears to me that one of the objects to be aimed at is to prevent the total evaporation of the solvent.

A cement that has been specially recommended to me is a mixture of two third parts of gum damar dissolved in benzole, and one third coachbuilder's gold size. This has undoubtedly very good qualities; it flows readily from the brush, is very adhesive to glass, and makes a perfect joint between the cover-glass and slide. The water or solution of formalin in the cell has no effect upon it. On the other hand I have been warned against the use of gum damar, because when its solvent is all evaporated it can be scraped off as a white powder; but the admixture of gold size modifies this property considerably. Gold size alone has long been known as a good cement, and I have been recommended by a maker to use the variety known in the trade as "Extra Stout," which is not so liable to run in, and which never becomes absolutely hard and dry, and when scraped comes off in strings. Pure gold size, however, does not adhere so strongly to glass as when mixed with gum damar. The solvents of gum damar and gold size are benzole and turpentine, and it has been suggested to me by Dr. Measures that the evaporation of the last trace of these solvents might be prevented by covering the gold size with a ring of another cement, having a purely alcoholic or naphtha solvent.

Such a cement is Ward's brown cement. In some respects this cement resembles Miller's caoutchouc cement, but it contains no caoutchouc and is more finely grained and better in quality; it dries with a fine gloss, never cracks, and is not attacked by benzole or turpentine; its composition is not known, and its best solvent is a mixture of wood naphtha and methylated spirit.

Taking all these considerations into account, I have of late sealed my fluid cells, which are hollows ground out in the glass slip, containing mounted Rotifers, as follows:—First I close the cell with the gum damar and gold size cement, which fixes the cover-glass firmly to the slide; when this is dry I put on a ring of the pure gold size, and when that is dry a third ring of Ward's brown cement, taking care that each succeeding coat slightly overlaps the previous ring.

In this way I hope and trust that my slides may remain permanent, but it will take years of experience before a definite judgment can be pronounced.

A few days after reading the above paper, Mr. F. Hughes was

good enough to send me an old slide, an anatomical preparation, mounted in a deep glass cell in some watery fluid with a small bubble in it, which he said was at least forty-five years old. Mr. Hughes could give me no further information, except that the bubble had always been there, and had most probably been left in the mount intentionally to act as a safety valve against the expansion of the fluid. Here, then, is a fluid mount which can be called permanent, and I therefore tried to find out who the mounter was and how it was closed. It has two coats of cement, first a yellow cement like gold size, and over that some black alcohol cement. Mr. W. T. Suffolk, the treasurer of the R. M. S., with his great experience in such matters, was able to give me full information on this slide, and such valuable suggestions regarding fluid mounts in general, that I cannot do better than give here long extracts of his letters.

In reply to my inquiries Mr. Suffolk wrote the following :—

"The slide you send me is by Hett, a well-known mounter. The period you name is correct; I have a few of his slides purchased about 1854-5. All I have are still in good condition; the included air bubble is in all of them. I consider the yellow varnish to be gold size, which was much in use by the best of the early mounters; the black finish is probably a mixture of shellac and lamp black, added merely for ornament and harmless under the circumstances: the bare gold size would not have been sightly enough for sale purposes. The usual mounting fluid for such preparations (thick injected organs) was dilute alcohol; sometimes a saline solution, sometimes a little creosote has been used with the alcohol, with or without glycerine. In remounts I have successfully replaced it with distilled water + 5 per cent. carbolic acid + 5 per cent. glycerine; this mixes freely with any of the above fluids and gets rid of the volatile alcohol—which I think it well to do. The inclosed air bubble I consider good, and when a cell contains any quantity of fluid I always use it: it acts as a spring, the expansion of the fluid in a perfectly filled cell sooner or later forcing the weakest point of the cell when it expands from increased temperature. The included air bubble is a very different thing from an intruded one, which always means mischief.

"I have had no experience of formalin, but from its composition should consider that, like alcohol, it would attack shellac, therefore think you have done right in using gold size. I have rather

a dislike to varnishes and cements of which the composition is unknown, as, however well they may be spoken of, you are quite in the dark as to their action on mounting fluids.

"My varnishes are practically two: gold size,—this is composed principally of boiled linseed oil, possibly combined with a resin dissolved in turpentine, in fact a first-rate oil varnish. It should be obtained at a good shop and be of the best quality. My other varnish is shellac, which I always make myself; it is almost as easy to make as gum-water. Simply place the best shellac you can obtain in a large bottle not more than half or three-quarters full with strong alcohol, shake up frequently until the lac is dissolved; it is best made at ordinary temperature. The result is a turbid mixture. If you make about half a pint, add a teaspoonful of red lead to the solution and shake it up; in a few days the red lead will have carried down all the thick matter, leaving a fine clear varnish, which decant.

"Shellac varnish resists glycerine and its compounds, but has the defect of being brittle, unlike gold size, which retains considerable toughness after the lapse of many years. For ringing balsam mounts I add twenty drops of castor oil to 1 oz. shellac varnish, but for other purposes use it pure.

"The principle of securely closing a cell containing fluid is to use first a varnish not affected by the medium, irrespective of its brittleness, and when the fluid is secure, case with a reliable varnish for security.

"My practice with glycerine and compounds is this, which will show what I mean. When I have put on the cover I clear away with a fine pipette and suction as much fluid as I can, absorbing the rest carefully with scraps of blotting paper; I then ring with a solution of damar in benzole, a weak and bad varnish, but which has the useful property of sticking to wet glass. When dry I wash under a tap so as to remove all traces of glycerine; this is important, as no sound joint can be made so long as glycerine or other fluid that persistently adheres to glass is in the way. I then follow with a ring of shellac (pure), when dry wash again and then give two or three coats of shellac, washing if there is any doubt about the joint being perfectly clean. The glycerine is now secure, and the mount is then secured with gold size, which should be laid on thinly and at least six coats. I have never found a slide to leak. If gold size had been used at once the very

penetrating glycerine would soon have found its way through. This is the general principle, varying the varnishes as circumstances and the mounting fluid require. Marine glue, much in vogue for securing cells to glass, has failed to stand the test of time; india-rubber compounds are notoriously unstable. For fixing glass cells on slips I have made a firm joint with a mixture of red lead and white lead after the manner of the blacksmith's hot-water joint. I take flake white from the tube and work powdered red lead into it with a palette knife until it becomes too stiff to work comfortably; I then dilute with gold size only a small portion at a time as I want it, as it hardens very rapidly when the gold size is added. Press the cell hard down so as to have the thinnest secure film of cement, and keep in a warm place for a few days; turn off the surplus ooze before it has become too hard, and do not use the cell for at least a fortnight. Your excavated cells and solid cast ones used by Hett are of course better than any built-up ones."

It will be noticed that Mr. Suffolk advocates five or six thin coats of gold size instead of one thick one. The reason is that oil varnishes, after the evaporation of the turpentine, harden not by evaporation of the oil, but by its oxidation, forming a tough layer, and therefore the process goes on best in a thin layer.

After carefully considering all that I have learned by Mr. Suffolk's letters, I would recommend for extreme durability for fluid mounts such as mine, in which the mounting fluid is formalin, or similar watery fluids, first a coat of pure damar in benzole, then a coat of the mixture of damar and gold size, followed by three or four thin coats of pure gold size at intervals of twenty-four hours, and lastly a finishing coat of Ward's brown cement. The "extra stout" gold size I am inclined to discard again, because it does not adhere to glass so firmly as the ordinary quality.

On the Evolution of the Microscope—Part 2.

(Continued from page 356, Vol. 6, Ser. 2.)

By Edward M. Nelson, P.R.M.S.

(*Taken as read, June 17th*, 1898.)

Since the publication of Part 1 a microscope which contains a very important feature has been found; as its date is 1702 it should be inserted in Part 1 between Hartsoeker's and Wilson's screw-barrel microscopes. Fig. 10,* which is a back view of it, shows an oval wooden plate; on the other side of this is a similar plate, which holds the lens in such a position that it is opposite the aperture A. Between the two plates there is a rotary multiple object holder (MN, Fig. 11), the object being inserted in apertures in the circumference of the disc. Focussing is accomplished by means of the milled head B, which is attached to a screw which regulates the distance between the two plates, one of which carries the lens, the other the rotary object holder. The point of interest in this instrument is the rotating wheel of graduated diaphragms A, C, D, E, placed, as you will observe, on the side of the object remote from the lens. This is the first instance where we meet with this useful appliance, which survives to the present time.

This pre-dates the loose diaphragms mentioned in connection with the Wilson screw barrel, and is far superior, both from an optical and mechanical standpoint, to Musschenbroek's sector of diaphragms, placed in front of the lens.

This microscope is similar in design, with the exception of the rotating wheel of diaphragms, to an Italian microscope (date 1686), which had, in place of the rotating wheel, a single diaphragm in a disc Q pivoted at R, capable of being turned to

* Copied from Zahn's *Oculus Artificialis*, 2nd Ed. (1702), page 796.

one side out of the axis, Fig. 11.* This is the first notice of a diaphragm for the purpose of regulating the illumination. The rotating disc MN is better seen in Fig. 11, and the focussing arrangement in Fig. 10.

Dr. Smith, who in his *Compleat System of Opticks* (1738) gives an excellent and precise account of the microscopes of his

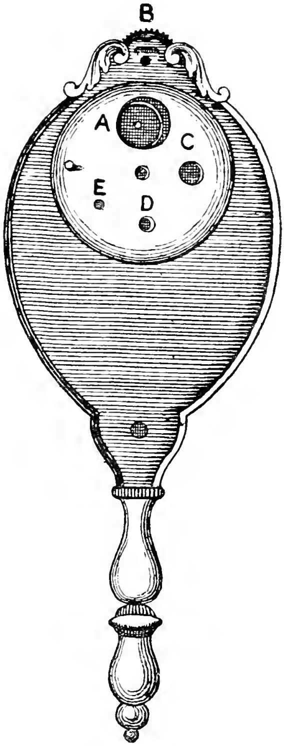


Fig. 10.

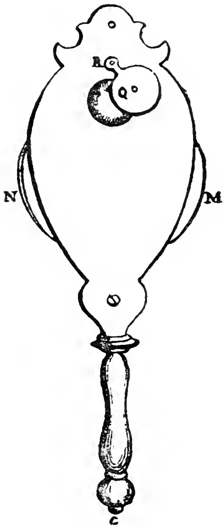


Fig. 11.

day, and the way to use them, makes no mention of diaphragms. He says, "In the viewing objects, one ought to be careful not to hinder the light from falling upon them, by the hat, peruke, or any other thing." With regard to the condensing lens of the Wilson screw barrel he says: "The only use of the convex lens at

* From *Nuove inventioni di tubi ottici* (1686): see Mayall's Cantor lectures, Dec. 7th, 1885, p. 26.

C is to collect the light into a narrower compass where it falls upon the object, after it has passed through a moderate hole in the leather F."

It should be noted that the leather F was only a friction washer, it was not used for the purpose of a diaphragm at all, neither was there any arrangement provided so that the size of the aperture could be altered, or the leather changed. Consequently we must come to the conclusion that a changing diaphragm was unknown to Dr. Smith. The passage therefore in Part 1, p. 354, which calls attention to Henry Baker's account in 1742 of the two diaphragms in Wilson's screw-barrel microscope as being the first notice of the use of diaphragms to regulate the illumination, requires alteration.

In 1710 we meet with a crude estimate of aperture, for Conradi says that the aperture of his object glass was equal to a mustard seed. This observer also used a negative amplifier between the objective and eye-glass; * this is the first notice of a Barlow lens.

In the previous article we left off at J. Marshall's microscope (1704), in which we found the important change from the "telescope stand" to that of an inclinable limb holding both the body and the stage. This is as decided an advance in the evolution of the microscope as the advent of a vertebra is in zoological evolution. In our next example, however, in so far as the mount is concerned, we come to a throw-back to the older type, but in other respects we find several important originalities. If we turn to Fig. 12 of Hertel's microscope (1715) we shall see that the mount is of the "telescope stand" type, the inclination in arc being regulated by screw and nut. This mechanical contrivance has for long left microscope workshops, but it is to-day very largely employed in regulating the swinging windows in the saloons of passenger steamships.

The stage is like a circular table mounted on a central pillar. Round the centre of the table are three circular openings, one of which holds a black disc, one a white disc, the third being left clear for the examination of transparent objects. Below this clear opening is a plane mirror, an adaptation which survives to the present day. The box foot does not contain the usual drawer for apparatus, but holds machinery for the movement of the stage. The butterfly nuts, which, strange to say, are placed in front of

* *Rees' Cyclopædia*: Art. "Microscope."

the microscope, (one would have thought that they would have been more conveniently placed behind the pillar,) regulate the movements of the stage; one causes it to move vertically up and down for focussing, another makes it advance to and from the pillar—this would now be called the vertical movement of a mechanical stage; the third and lowest nut rotates the stage. Attention must be given to this last point because this is not

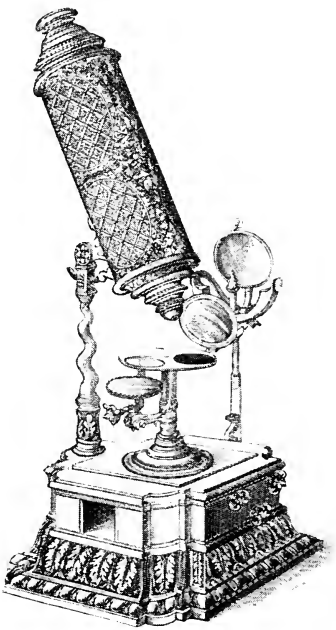


Fig. 12.

what is now known as a rotary stage, but it is a transverse movement in arc, a device not altogether unknown in recent times.

Artificial illumination is provided for opaque objects by means of a candle, a concave mirror, and bull's eye; this plan, however, cannot claim originality, as it had been previously employed by Hooke (in Part 1, Fig. 3, Vol. 6, Ser. 2, p. 351, the concave mirror is not shown). The two points in the history of the evolution of the microscope presented by this instrument are the mechanical stage and mirror.

The next microscope is of the simple kind, invented by M. Joblot, Professor of Mathematics at the French Academy of Fine Arts. The ornamented plate, seen in Fig. 13, holds the lens, the focus being adjusted by the nut and screw; the plate next to the ornamental one is a concentric rotary stage. The mechanical details of this stage are well thought out, and it is properly sprung

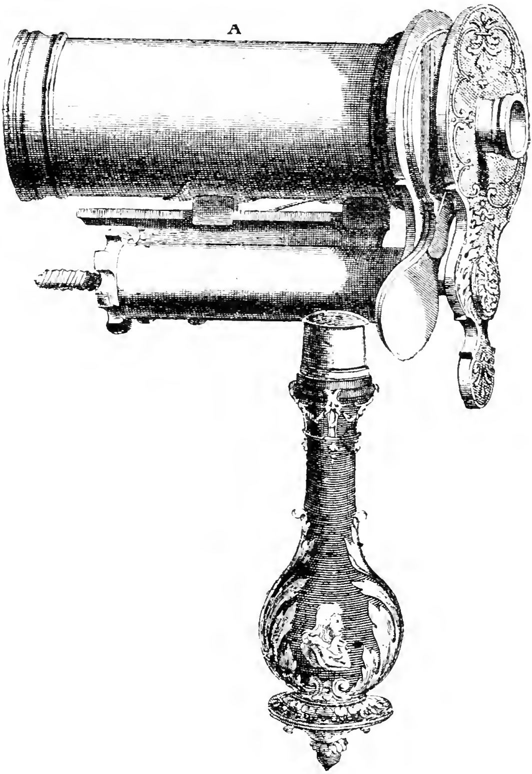


Fig. 13.

(see Fig. 14). The tube A, Fig. 13, called by the inventor "the canon," which is lined with black cloth or velvet, has a diaphragm at each end; these diaphragms are held in position by movable caps, which allow the diaphragms to be changed. This microscope is a decided advance on any of the simple microscopes that preceded it, not only on account of the mechanical contrivance of the

concentric rotating stage, but also for an optical one—viz. the placing of a diaphragm at the end of the tube or "canon." Let any one try this plan with a non-achromatic lens and a blow-fly's tongue, and they will soon find how much control can be exercised over the mist and fog arising from the chromatic and spherical aberrations of the uncorrected lens.

Prof. Joblot also designed compound microscopes; these, although their exteriors are ornate and of good artistic design, are of a very crude type; they possess, however, one point of interest—viz. that there is stored in the covering cap of the eye-piece a concave lens. This, when mounted in place of the convex

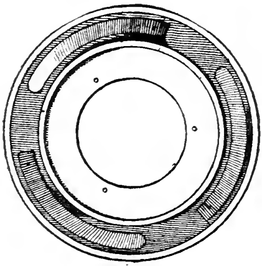


Fig. 14.

eye lenses, turned the instrument into what is now known as a Brücke lens.* Prof. Joblot's book, which is profusely and well illustrated, is divided into two parts; in the first of these, which deals with objects seen with the microscope (principally those obtained from decomposing infusions of various substances), there is a water animalcule figured with a man's face on his back; all these plates were subsequently reproduced in Adams' *Micrographia Illustrata*. The second part is entirely devoted to microscopes, working drawings being given of most of them. The date of the first edition is 1718, and this is the date of the microscopes.

We now come to two catoptric microscopes, the first by Barker in 1736; it is unnecessary to give a figure, for two reasons: first,

* His figure is not very distinct, and his meaning with regard to this subject is involved.

it is precisely similar to a Gregorian telescope; secondly, the design is bad, because (*a*) the small mirror gets in the way of the object, so that the object cannot be viewed unless it is placed at a considerable distance from the large mirror,—the optical index, therefore, of the instrument would be small; (*b*) in order that the instrument may be aplanatic, both mirrors require to have ellipsoidal curves which are impracticable, and when spherical curves are used the aberrations are additive.

The next, Fig. 15, is a very efficient form of catoptric microscope by Dr. Smith (1738), which is like a Cassegrainian telescope, with this difference, that both mirrors are pierced with a hole through their centres. Dr. Smith calculated four of these microscopes, the main difference between them being in the residual

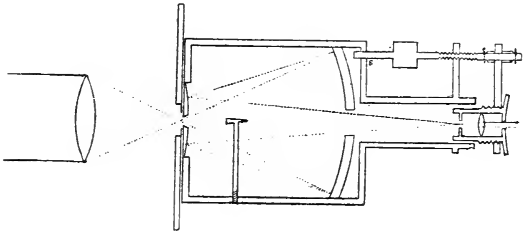


Fig. 15.

amount of spherical aberration they possessed (No. 3 having the least). The calculations were for spherical curves; the aberrations being subtractive the instrument is consequently far superior in design to Barker's. He also describes the use of a substage condenser, which had its aperture equal to that of the objective mirror, the object being placed at their joint foci. The foci of the mirrors were alike, and were 1 inch; the power of the microscope was 300 diams.; the objective metal having the large optical index of 32. This microscope was surpassed neither theoretically nor practically for about eighty or ninety years.

We now come to Culpeper and Scarlet's microscope: this was known as a "double reflecting microscope," and was first described by Dr. Smith in his *Compleat System of Opticks*, 1738. The only point of importance to notice with respect to this model is that it is the first instance where we meet with an illuminating mirror

in an English microscope. The mirror is concave. The very inappropriate name "reflecting" given to this microscope was owing to the illuminating mirror; it was essentially a dioptric and not a catoptric instrument. Dr. Smith, in his account of it, suppresses the word "reflecting."

As Fig. 16 explains itself, it will only be necessary to notice a

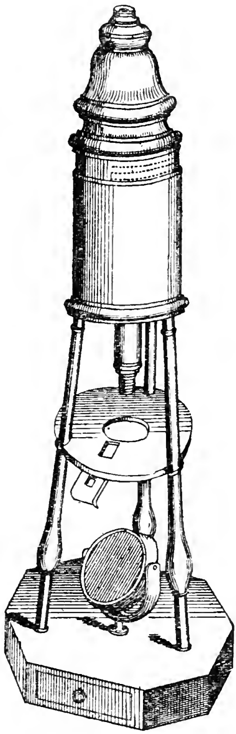


Fig. 16.

few minor points: first the unscrewing of the objective on the nose piece was used as a fine adjustment, the coarse adjustment being performed by placing the sliding tube to a mark. The three brass pillars constituting a non-inclinable rigid tripod were an improvement on the Divini and Cherubin d'Orleans. This microscope is by Baker in 1742 called an improvement of J. Marshall's, but this is surely a mistake, as they have nothing in common except the octagonal box foot.

Baker, in his description of this microscope in 1743, adds a conical diaphragm made of black ivory (Fig. 17). A diaphragm of this form made of brass was subsequently used by Cuff, Benjamin Martin, Adams, and in 1798 by Jones. Chevalier placed a graduated wheel of diaphragms at the lower end of the cone (1823), so this peculiar form of diaphragm had an innings of about eighty years.

[With regard to the graduated wheel of diaphragms, it is interesting to note that this useful appliance has not hitherto been found in any microscope between the dates 1702 and 1823; but I have lately acquired an old French microscope which has the graduated wheel below the cone. The date of this instrument is unknown, nor can it with certainty be determined, for the body has an archaic appearance, being something

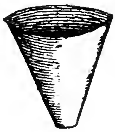


Fig. 17.

like Joblot's compound microscope; but as the stage has a rack-and-pinion focussing movement, its date cannot be earlier than about 1765.

If, on the other hand, its date is prior to 1823, then the microscope is especially interesting as being the first known example of the revival of the graduated wheel of diaphragms.]

The object-glasses, which were five in number, were called "buttons"; this term has now died out, but it was still employed twenty years ago with reference to the French achromatic doublets largely used by medical students. The Culpeper and Scarlet model continued to be a popular form of microscope for seventy years.

In a fine old example, made by Nathaniel Adams, the legs are of brass, the outer tube is shagreen, and the nose-piece wood, the object-glasses also being mounted in wood.

G. Adams also made these microscopes with the following alterations: the legs below the stage were scrolled, and those above it were of the form of vertical pillars; the box foot was

square. This instrument is figured by G. Adams in *Micrographia Illustrata*, 1746. The last time we meet with it is in the second edition of the *Essays on the Microscope*, by G. Adams,* 1798. Here it is made entirely of brass, the legs both above and below the stage highly scrolled—a device which certainly gives more room for manipulating either the object or the mirror. A rack-and-pinion focussing adjustment was sometimes fitted to it by Jones.

This is the proper place to treat of micrometers, because up to the time we are considering (1738) Leeuwenhoek's method of comparing objects with the bigness of a grain of sand had been employed. The following quotation from Dr. Smith's *Opticks*, p. 405, will show the progress that had been made on that crude method. "Those that are curious in making exact draughts of the appearance of objects seen in double microscopes may be very much assisted by a lattice made with fine silver wires, or with the strokes of a diamond upon a plane glass, put into the place of the image formed by the object glass; and by transferring the parts of the object, seen in the squares of the lattice, into corresponding squares of a similar lattice drawn upon paper. It may also be of singular use in philosophical enquiries to know the exact measures of the several vessels and other parts of animal and vegetable substances; and this, as Mr. Balthasaris has observed in his little treatise upon micrometers, may be done very exactly by a micrometer of the same form as is used in a telescope. For by opening the hairs of the micrometer till they exactly comprehend an object of a known length, suppose $\frac{1}{10}$ inch, and by observing the number of revolutions in this opening, the diameter of any other object answering to a known number of revolutions may be found by the golden rule."

Here we find fully described the most approved methods, which are still in use both for drawing and measuring microscopical objects.

* With regard to the Adams optical firm, there is a mention of a Nathaniel Adams (optician to H.R.H. Frederic Prince of Wales). This might have been the father of George Adams, who published the *Micrographia Illustrata* in 1746. *Essays on the Microscope*, 1787, were written by George Adams (son of the preceding); he died in 1795; and W. and S. Jones of Holborn, who took over his business, published a second edition in 1797. In this year Dudley Adams, son of George Adams, took out a patent with regard to spectacles.

[It may be interesting to note that the screw micrometer for a telescope was invented by William Gascoigne (1639). His plan was to separate the edges of two plates by a differential screw, which had one thread twice the fineness of the other. A frame carrying both plates was moved across the field by the fine screw, the coarse screw moved one plate away from the other at double the speed, therefore both plates moved from each other at an equable rate. Gascoigne, at the age of twenty-four, was killed at the battle of Marston Moor (1644).

It must be noted that this differential screw, which in 1775 was applied by Ramsden to a divided lens micrometer, was not used as a means of obtaining a slow movement with two coarse threads,

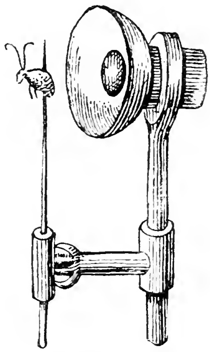


Fig. 18.

but only for opening or closing at a uniform rate the edges of the micrometer plates. If at the present time a similar apparatus were required, it might be accomplished by means of a right and left handed screw on the same pinion.

Fine silver wires were substituted for the edges of the plates about 1666, and subsequently Troughton replaced the wire with a spider's web.]

To return, however, to our legitimate subject, it was at this time (1738) that Dr. Lieberkuhn introduced the reflector, which is still called after him; the design can hardly be called original, as it had been figured and described by Descartes one hundred years previously (see Part 1, Fig. 2, p..350). To show the crude form in which it was first applied, Fig. 18, which was found by

the late J. Mayall, Junr., in the *Essai de Physique*, by P. Van Musschenbroek, Vol. 2, Pl. 18, Fig. 6, Leyden (1739), is inserted.

It would seem that the conditions laid down in Descartes' figure—viz. that the foci of both the mirror and objective should be identical—were not adhered to, for we find the same speculum used below lenses of very different foci.

Cuff subsequently improved this by making the mirror slide on a long cylindrical nose-piece, its proper position for use with any particular objective being indicated by a numbered mark corresponding to a number on the objective (see E, Fig. 23). Dr. Lieberkuhn's latest development of this apparatus consisted of a short cylindrical tube, at one end of which was a concave speculum $\frac{1}{2}$ inch in focus, having the usual hole at its vertex, in which was mounted the lens, also $\frac{1}{2}$ inch in focus; at the other end of the tube there was a biconvex condensing lens, the object being placed on a sliding pin between the condensing lens and the speculum.

Here the speculum and lens have the same focal lengths, but still Descartes' idea is not carried out, because the speculum is mounted nearer the object than the lens, for the purpose of focussing the convergent rays that fall upon it from the condensing lens. This, optically speaking, is a very indifferent arrangement, because the diameter of the condensing lens being equal to that of the speculum, the condensed rays can only fall on the central portion of the speculum, which of course has not much effective area owing to the hole in it.

Dr. Lieberkuhn may perhaps have been the first to practically use Descartes' invention, but all his adaptations of it were of the crudest kind, and have quite passed away; whereas Cuff's form of mounting it remains.

To Dr. Lieberkuhn we are indebted for a solar microscope, so called because direct sunlight was used as an illuminant; now, however, we should call it a projection microscope. (Exhibited together with the Lieberkuhn by the Doctor himself in London in 1740.) Originally the apparatus, which was mounted through a ball and socket in a window, was pointed directly at the sun; but this was altered and greatly improved by Cuff (1743), who attached an elementary form of heliostat (see E, Fig. 19), which permitted the microscope to be kept in a horizontal position, the thumbscrew T causing the mirror E to rotate round the optic

axis. In 1746 Adams adapted his microscope stand in a very ingenious manner to this projection apparatus, thus forming the earliest prototype of the projection and photographic instruments of the present day. (Fig. 19.)

Without anticipating the description of Adams' microscope, it may be stated that the instrument is of a vertical non-inclinable form with a folding tripod foot. The front leg of the tripod has a circular aperature in it, through which the conical nose of the illuminating portion of the projection apparatus is inserted, the microscope being placed in a horizontal position. Adams' solar projection microscope has been chosen as typical of the whole series; Cuff's, which is figured in the second edition

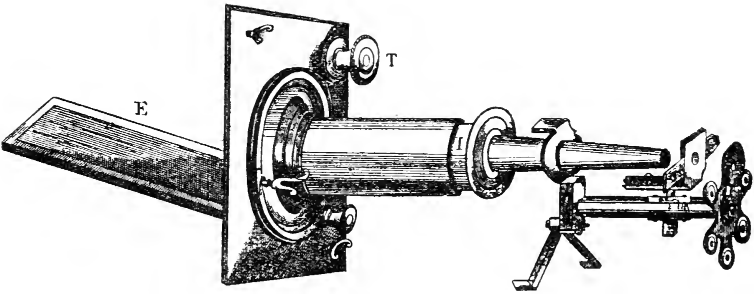


Fig. 19.

of *Baker on the Microscope* (1743), has the illuminating portion of the apparatus similar to Fig. 19, but the microscope part of it is different.

After occupying so much space over the year 1738, we will pass on to the next year, when we meet with the first microscope designed by that celebrated mathematician and inventor, Benjamin Martin.*

* Benjamin Martin was born at Worplesdon, in Surrey, in 1704, and began life as a ploughboy; afterwards (*circa* 1734) he became a schoolmaster at Chichester; subsequently (*circa* 1759) an optical instrument maker at the Sign of the Visual Glasses and Hadley's Quadrant, 171, Fleet Street. He was also an author, and published about thirty-nine works on physical science, mathematics, optics, astronomy, etc. He died in 1782, and in this year his son Joshua Lover Martin took out a patent for drawing metal tubes. (See admirable account of B. Martin, by John Williams, *Trans. Mic. Soc. Lond.*, Jan. and Oct. 1862, Vols. 2 and 3, New Ser., p. 31 and p. 1.)

His first instrument was called the Pocket Reflecting Microscope with a Micrometer, an account of which he published in 1739.*

This instrument was dioptric; the word "reflecting" applies solely to the illuminating mirror, as was before noted in the case of the Culpeper. Fig. 20 shows that it was of an entirely novel design; the focussing was performed by a push tube at B; for illumination the outer tube was cut away in front, and a mirror was placed at the bottom; there was also an aperture, P Q, cut through the opposite side of the outer tube for the purpose of allowing sliders to be passed through. One of the novelties this microscope possessed was a rough micrometer fitted in the focus of the eye-lens, with an attached dial for the purpose of registering the tenths of a revolution of the screw. The price of this microscope, including the micrometer, was £1 1*s.*, without the micrometer 10*s.* 6*d.* Subsequently the outer tube was prolonged, making what is now known as a drum foot, in which a mirror was placed; afterwards it was mounted on three legs after the manner of the Culpeper.† This form of microscope has been largely employed, principally on the Continent, and even now we still find microscopes of this design in toy shops. The novelties in this design are therefore the drum foot and the attachment of a micrometer to the microscope. B. Martin has been held to have been the inventor of the principle of microscopic micrometry, but from what we have seen above he was clearly pre-dated in this respect; he was, however, the first to attach a micrometer permanently to the microscope.

Another instrument was designed by B. Martin in 1740, called the Universal Microscope; its form was too crude to call for more than a passing notice. The foot was an octagonal box; the body, which had push-tube focussing, was attached to the top of a pillar by a ball-and-socket joint; the stage had transverse motion in arc. This, in short, is a throw back to the telescope form of mount; but from about this time we shall see less and less of it, because the invention of the mirror rendered the telescope mount

* For this date see *Adams on the Microscope*, second edition (1798), p. 21, footnote.

† Both these improved forms are figured in *Martin's Tracts*, a book in the Royal Microscopical Society's library. It is unfortunate that the particular tracts which contain these figures are undated.

not only unnecessary but positively injurious. It is true that,

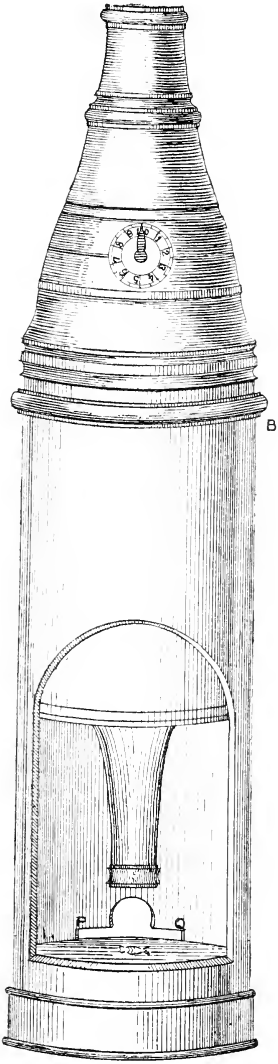


Fig. 20.

before the mirror had been invented, Marshall had not made use of the telescope mount in his design; yet, if the matter be duly

considered, it will be seen that, because the illumination of transparent objects with the mirror, and of opaque objects with the mirror in conjunction with the Lieberkuhn, became so easy, there was no need to turn the optic axis in any other direction than that of one at right angles to the stage (though not necessarily, as now, central to it). We find, therefore, that the mirror, although applied in the first instance to a telescope mount, became an important factor in determining the fixture of the optic axis in a position at right angles to the stage. Undoubtedly the mirror was the principal agent in extinguishing the hand microscope of the type of Leeuwenhoek, Musschenbroek, Joblot, Lieberkuhn. In illustration of this point it will be remembered that in Part 1, Vol. 6, p. 354, it was stated that Culpeper had mounted Wilson screw-barrel microscopes on a stand (telescope mount), and had added a compound body and a mirror to them.

(In 1738 Dr. Smith alludes to mirror illumination in connection with the Wilson screw barrel, and also to the addition of a stand [*Compleat System of Opticks*, p. 401], but he does not mention the attachment of a mirror to the stand of a Wilson screw barrel, and from the way he treats the subject it is probable that he was not acquainted with any form of Wilson microscope mounted on a stand with a mirror attached.)

The precise date of these Culpeper-Wilson microscopes has not been determined, but fortunately we have an excellent example of the other kind figured by Baker in 1742.* Fig. 21 shows a scroll form of mount on a circular wooden foot—a great improvement over the complete telescope mount; but we see the last remnant of a partial telescope mount, for the microscope could be turned round on the pin CD laterally, so that it might be pointed to the sky or to a candle flame. This form of microscope, as made by Adams (see Adams' *Micrographia*, first edition, 1746), which had the scroll made in sections for the sake of portability, and which was mounted on a square box foot, became very popular, and was still sold by Jones in 1798.

* Baker does not give the name of the maker of this microscope. They were made by Cuff, Adams, Mann and Ayscough, perhaps also by Culpeper and Scarlet.

The next microscope, Lindsay's (Fig. 22), is a simple microscope with a mirror attached. It has four points of interest: first, its extreme portability; secondly, its excellent workmanship; thirdly, it is the first microscope in which we meet with a mechanical arrangement for changing the power; fourthly, it is the first microscope that was patented.

Although it has a folding tripod stand to which it can be attached, it is essentially a hand microscope, because the stand

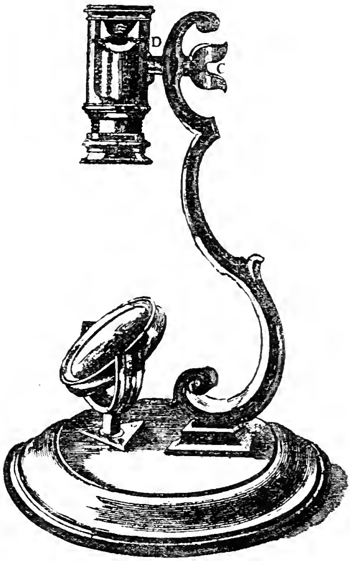


Fig. 21.

is too slight and unsteady for serious work. It has stage focussing by means of a lever.

The powers, which are equi-convex lenses, are seven in number, and are burnished into two slips of metal, four being in one and three in the other; these slips fit in a groove behind an eye-hole, the power being changed by merely sliding the slip to a mark engraved on it, which denotes the power. A sliding slip of powers became afterwards a rotating wheel of powers, the prototype of the revolving nose-piece of the present day. It should be noted that these slips have a small spring fastened

to them, to ensure a smooth motion in the groove in which they slide. George Lindsay was a watchmaker in the Strand,* which accounts for the excellent workmanship found in his microscopes. The date of the patent of this microscope is 1743; but it is stated by the inventor, in an account of the instrument, that he designed and made it in the year 1728. If this earlier date could be established, it would be the earliest known instance of an English microscope fitted with a mirror.

There is a perfect specimen of one of these pretty microscopes in the cabinet of the Royal Microscopical Society, which is dated

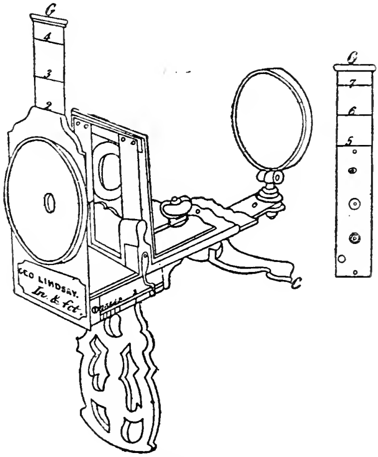


Fig. 22.

1742, and numbered 22; it is therefore in all probability the earliest existing example of an English microscope with an attached mirror as well as of the Lieberkuhn. The outside measurements of its box are $3\frac{1}{16} \times 2\frac{1}{4} \times 1\frac{5}{16}$ deep.

The last microscope to be noticed at this time is an important one—viz., Cuff's, Fig. 23. The post AB is fixed to a square box foot, and the stage is fixed to this post. The bar behind and parallel to the post, to which the limb D carrying the body is attached, slides in the socket B. The thumbscrew in front clamps C, which is fixed to the movable bar, to the post A. The method of focussing is therefore simple and effective. The

* At ye Dial near Catherine Street in ye Strand.

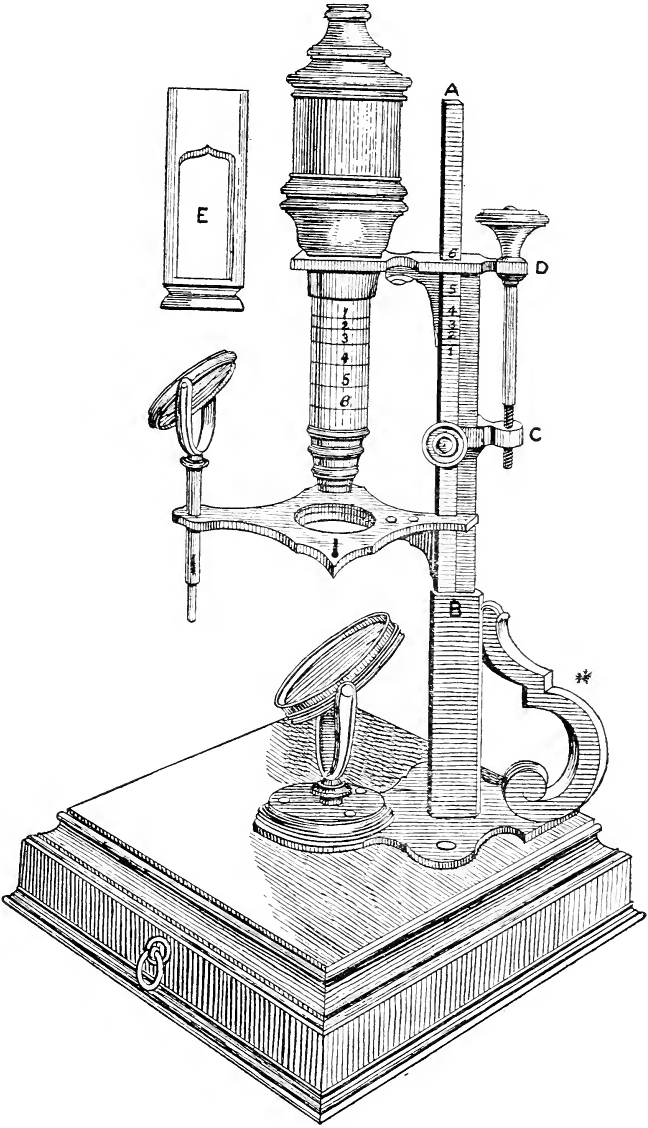


Fig. 23.

thumbscrew is loosened and the movable bar is placed to the figure engraved on the post A, corresponding to the number of

the objective on the nose-piece. The thumbscrew is then clamped tight, and further focussing performed by the fine adjustment DC. This microscope is very similar in design to that of J. Marshall (see Part 1, Fig. 9, p. 355), excepting the important addition of a mirror; it is however better finished and not so unwieldy. It will be noticed that both are body focussers in contradistinction to the stage focussers so much in vogue at that date. There is one novel feature in the mounting of the Lieberkuhn (E, Fig. 23), which has already been explained above. The date of this microscope is 1744.

Note on Tick Fever in Cattle.

By C. J. Pound, F.R.M.S.

(*Read June 17th*, 1898.)

I have worked out protective inoculation for Tick Fever. Up to the present time some thousands of head of cattle have been inoculated, and the results have proved highly satisfactory, for when such cattle are subjected to gross tick infection, or injected with virulent blood, they remain perfectly immune, while the "controls," or unprotected animals, subjected to the same conditions, are readily attacked with severe and acute fever, which often ends fatally.

So successful have our experiments been that numbers of stock-owners, whose cattle are threatened with an invasion of tick, have lost no time in systematically inoculating the whole of their herds.

I have been kept busy inoculating a number of valuable stud bulls and heifers from Victoria and New South Wales, which are to be sent to North Queensland, where the ticks are very bad. By the same mail I am sending you some bottles containing several species of ticks (preserved in 3 % formalin), with notes on the locality, and the animals, native or otherwise, I have found them on. You will notice that in some species I have only sent females, as the males I have never seen, nor has any one I have met, such as observant bushmen, who are constantly meeting with ticks.

I may tell you that every species of tick (other than the genuine Cattle Tick, the cause of "Tick Fever" or "Red-water" in cattle) is known to bushmen, squatters, etc., as the "Scrub Tick." Our museums throughout the Colonies cannot give any reliable information respecting ticks, nor have they even a representative collection of the known species which are commonly met with, consequently there is a vast unexplored field of research in this direction.

You might mention at one of the Club meetings that if any Queketters who have a substantial pension want to spend life happily and comfortably in the most glorious of all climates they had better settle down in Queensland, where they will have endless opportunities, facilities, and material of all kinds to work upon. It is astonishing in the Colonies what a very few people undertake microscopical investigations; in Brisbane, I believe, you could not muster more than five altogether, and then the work is very occasional, but we have a really good man in Dr. Thomson, some of whose work I will send you at an early date.

March 18th, 1898.—Ordinary Meeting.

J. Tatham, M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Charles Combe and Mr. Walter E. Williams were balloted for and duly elected members of the Club.

The following additions to the library were announced :—

"Missouri Botanical Gardens Report" ...	From the Director.
"Transactions of the Northumberland Natural History Society," No. XIII.	" Society.
"The Botanical Gazette"	" Editor.
"Proceedings of the Geologists' Association"	In exchange.
"The American Monthly Microscopical Journal"	" "
"The Microscope"	" "
"Science Gossip"	" "

Mr. Karop called attention to a new scientific publication being brought out in Paris, which he thought was likely to be extremely useful to many. It was entitled "L'Intermédiaire des Biologistes," and was a sort of scientific Notes and Queries. The editor was Prof. Alfred Binet, who was assisted by a board of directors. Questions might be sent in any European language, and the answers would be given in the original, with a summary in French, should the reply be in another language to this. The subscription was only 12 francs per annum, including postage, and the work was published fortnightly. He thought some members of the Club would be very glad to know of it, and he had therefore brought a specimen copy to the meeting.

The President said the members would hear with regret of the death of Mrs. Braithwaite, the wife of their former President, Dr. Braithwaite, and daughter of Mr. Ward, the inventor of the Wardian fern case. The Committee had that evening passed a vote of condolence with Dr. Braithwaite, and he felt sure all the members of the Club would desire to join in this expression of sympathy.

Mr. J. W. Reed read a paper "On the Æcidium stage of *Uromyces pisi* on *Euphorbia cyparissias* L."

The President said he was sure that even those members of the Club who were not students of the micro-fungi would be agreed as to the great interest which must attach to the paper read by Mr. Reed, and which would no doubt afford abundant material for that kind of discussion which was specially desired at their meetings. The micro-fungi were extremely difficult subjects to deal with, and although he had not himself taken them up as a study, he learnt a good deal about them which greatly interested him from the Rev. Mr. Vise, who some time ago paid a great deal of attention to the subject.

Mr. E. T. Newton congratulated both the Club and Mr. Reed upon the very interesting paper they had just heard read, which was just the kind of paper they wanted. He knew nothing of the subject, and therefore wanted to ask some questions. He could follow the account of these spores, but there were some other points which he should like made clear, and would ask if Mr. Reed had seen anything which might be regarded as analogous to a sexual process. If there were anything of this kind (which, it seems, Mr. Massee had pointed out) it would be a very important fact. Another point was, supposing they had such a thing as a perpetual summer, would the growth be continuous all the year round? This at present was not the case, and they found that in the autumn a different kind of spores began to be produced, such as were wanted for the production of new plants after the winter was passed. Possibly the reason was the same as what produced those remarkable changes amongst the Aphides, which so long as they were kept warm went on producing asexual offspring, but as soon as the temperature fell sexual individuals began to be produced.

Mr. Groves said he had not made a special study of the Fungi, and had gained much information from Mr. Reed's interesting paper. Cases of alternation of generation were particularly attractive to him. In the *Characeæ*, among which he was most especially working, the alternation of generations existed in a most rudimentary form. He had seen a very useful series of specimens which Prof. Stewart was preparing for the College of Surgeons Museum to illustrate "alternation of generations," and among them *Puccinia graminis*, to which Mr. Reed had referred. It

struck him that one of the most extraordinary points in the life-history of the *Uromyces* described by Mr. Reed was the great difference in the character of host-plants; and one of the most important problems to be solved was, what was the advantage to the Fungus of these different hosts? He suggested that probably the persistence of the perennial host carried on the existence of the species through periods when the annual was lacking; and, on the other hand, the annual host furnished much more suitable material for the rapid multiplication of the fungus. These plants showed an extremely complicated form of alternation of generations. It was not necessary to go so far as Switzerland to find out something about the life-history of these Fungi; there were many opportunities in our own country, and he hoped that those who had heard this most interesting paper would follow Mr. Reed's example and try to work out some definite subject during each of their summer holidays.

Mr. Slade said he understood from Mr. Reed that the young spurge plant might be infected in two different ways: that the spores might attack the rhizome, and also that the uredospores would infect the plant through the leaves in the ordinary way; so that the plant would be suffering at the same time from mycelium spores in the rhizome and uredospores in the leaves.

The President, in proposing a hearty vote of thanks to Mr. Reed for his paper, said that before putting this to the meeting he should like to make a suggestion as to a medium for mounting, because Mr. Reed had said that he found glycerine a good medium but somewhat sticky. He quite agreed with this as the result of his own experience; and he had tried glycerine jelly, but found that in course of time this also was unsatisfactory for a similar reason; but he thought if a neutral solution of chloride of calcium was used it would be found a very good medium indeed.

The thanks of the Club were then unanimously voted to Mr. Reed for his paper.

Mr. Reed, in reply to Mr. Slade, said that the uredospores did not infect the young spurge, but it must be infected either from the rhizome or by means of the secondary spores. He was much obliged to the President for his suggestion as to a suitable mounting medium; he had tried glycerine jelly also. He felt much indebted to Mr. Newton and to Mr. Karop—the former for having drawn the diagrams with which the subject had been

illustrated that evening, and the latter for having been so good as to make a very beautiful plate with which to illustrate the paper when it appeared in the Journal.

Notices of meetings for the ensuing month were then given, and the proceedings terminated.

April 15th, 1898.—Ordinary Meeting.

J. Tatham, M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. George H. Baxter, Mr. Woodhouse Braine, F.R.C.S., Dr. J. W. Simpson, and Mr. John Hounsome.

The following additions to the library were announced:—

"Journal of the Nova Scotia Institute of Science"	In Exchange.
"The Botanical Gazette"	,, ,,
"La Nuova Notarisia"	,, ,,
"Catalogue Général des Diatomées"	By Subscription.
"On the Experimental Study of Aperture as a Factor of Microscopical Vision"	From Dr. A. C. Mercer.

The thanks of the Club were voted to Dr. Mercer for his donation.

A paper by Mr. J. E. Lord, on two new species of Rotifers from Rossendale, was read by Mr. Bryce, who further remarked, with regard to the Callidina described in it, that after a long search in some material sent to him by the author, he had been able to find only two examples, neither of which was quite so large as the dimensions stated. He had made a cursory examination of the smaller of the two, a rather young individual, which he found to be fairly quiet under observation. So far as he could then say, the species seemed closely to resemble one found by Dr. Weber near Geneva, of which he had seen the original drawings, and a description of which was about to appear. The specific name proposed by Mr. Lord had already been employed in the

genus, and before another was substituted it would be desirable to learn the name given by Dr. Weber to his new form, in case the species should prove to be identical.

In this case Mr. Lord's form, if not altogether new, would still be new to Great Britain.

No one present responding to the invitation of the President to make any remarks upon the paper, the thanks of the Club were unanimously voted to Mr. Lord for his communication, and to Mr. Bryce for reading it to the meeting.

The Secretary regretted that, so many members being still away on their Easter holiday, there was less upon the agenda paper than usual. He then announced the meetings and excursions for the ensuing month, and the proceedings terminated with the usual conversazione.

MAY 20TH, 1898. ORDINARY MEETING.

J. TATHAM, M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. W. R. Adams, Mr. J. McGregor, Dr. T. Fuller, Mr R. S. W. Sears.

The following donations were announced:—

"Annals of the Belgian Microscopical Society"	From the Society.
"Annals of Natural History"	Purchased.
Peregallo's "Catalogue Général des Diatomées"	"
"Proceedings of the Royal Society"... ...	From the Society.

The thanks of the Society were voted to the donors.

The Secretary said they had another donation of considerable value presented by their good friend Mr. E. M. Nelson, and that was a collection of one hundred slides of Diatoms mounted by Professor Hamilton Smith, who was a well-known expert in the preparation and mounting of diatoms. This series would form a collection of typical slides, which would no doubt be of very great value to the Club.

The President said that, whatever might be the amount of interest taken in diatoms by various members of the Club, there

could be but one opinion regarding the value of this collection—it was simply unique—there was nothing like it, and he was sure they would pass a very cordial vote of thanks to their kind friend for his valuable present. This having been put to the meeting from the Chair, was carried with applause.

Mr. E. M. Nelson said he was much obliged to the members for the way in which the President's remarks had been received; he only wished it had been possible to obtain the complete collection, but he found it was not.

Mr. Nelson then read a paper upon Diatom structure as illustrated by specimens of "*Coscinodiscus Asteromphalus*," diagrams in further elucidation of the subject being drawn upon the board.

Mr. Morland in reply to the President said he had seen the slide upon which the particular specimen described by Mr. Nelson occurred, and thought that the appearance of immaturity was due to a want of silex; he also thought that instead of growing from the centre to the outside it was deposited simultaneously all over. He thought the other form described was possibly a form of *Raphoneis*, but could not be certain; it might be a described form, or a variation from some recognised type.

The President said Mr. Nelson had been good enough to come to their assistance that evening by providing the only paper on the agenda, and this paper they would agree with him in thinking a very excellent one. He was personally very much interested in these questions of minute structure, and had through Mr. Nelson's kindness been privileged to examine many of his specimens. He had got as far as secondary structure; but now it seemed they had been taking a step farther, and had got to tertiary structure, and he was afraid he should be obliged to worry Mr. Nelson until he let him see this also.

A vote of thanks to Mr. Nelson was then unanimously passed.

Mr. Nelson said he was indebted to Mr. Ingpen for this beautiful slide, the material of which came from the Nottingham deposit. It was just the sort of slide he liked to get hold of for this purpose, with the diatoms smashed up all over the slide. He had no intention of making another new species.

Mr. Ingpen said, as to the slide, its condition was no doubt only a page in a chapter of accidents; he scarcely remembered which one it was, but believed it had been sent to him as a sample of mounting in high refractive media; he believed in this case

the medium was antimony. The deposit itself was a very interesting one, and the interest was increased by the description they had had that evening of what had been found on the slide. Professor Hamilton Smith at that time was experimenting a great deal on media of high refractive index, such as bromide of antimony, bromide of arsenic and piperine, giving an index of a little over 2, and they certainly made the objects mounted in them very distinct. There was another thing about this particular culture worth mentioning, and that was, it had never been doctored to any great extent, and therefore the structure stood well in the process of mounting; and the fact of Mr. Nelson finding these tertiary structures was no doubt due to the material not having been over-washed. When mounting in these high refractive media he always found this particular culture was much more successfully dealt with than any other. He had not mounted these slides for the sake of the beauty of the specimens, but rather to see the effects of the different media, and it was found almost impossible to mount many of these forms without fracture.

Mr. Hardy asked if it was possible for a siliceous deposit to become altered after it was once deposited. If it was in a colloid form he could understand that this might be the case,—but supposing it was colloid, would it even then be possible to alter it after it was fixed, because acid did not affect it?

Mr. Karop said that it was true that the silica was not affected by acid, but it was very readily acted upon by alkalis. He also asked was this deposit from Nottingham in America?—because he noticed that Mr. Ingpen referred to it as a "culture," which seemed hardly the correct word.

Mr. Morland said it was a diatomaceous deposit discovered at Nottingham in Maryland. Later on a fresh find of material from the same locality was called "New Nottingham deposit."

Mr. E. M. Nelson agreed with Mr. Ingpen that the perfection of the structure in his slide was no doubt due to the fact that the material had not been previously over-cooked.

Mr. Ingpen thought it highly probable that if the diatoms were cleaned with acid and were not properly washed afterwards some of the mounting media would be affected in the way suggested by Mr. Nelson.

The President thought that in considering the special forms

which silicia might take in the structure of a diatom a possible explanation might be found on the theory that the process of deposit might be a vital process and not a mechanical one.

Mr. Ingpen said he was much inclined to this view, and had often thought that the development of a diatom might be somewhat the same as the formation of a shell, where the animal absorbed lime in a soluble form on one side and deposited it in an insoluble form on the other side. The tertiary structure might possibly be the very origin of the diatom.

Announcements of meetings, etc., for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

June 17th, 1898.—Ordinary Meeting.

J. Tatham, M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. Arthur H. Sutch and Mr. Kaufmann J. Marks.

The following donations to the Club were announced:—

"The Botanical Gazette"	In Exchange.
"Journal of the Royal Microscopical Society"	,, ,,
"Proceedings of the Royal Institution" ...	,, ,,
,, ,, Scottish Microscopical Society"	,, ,,
"Annals and Magazine of Natural History"	Purchased.
"Proceedings of the Geologists' Association"	From the Association.
"On Microscopic Images and Vision" ...	From Mr. L. Wright.
"Proceedings of the Royal Society" ...	,, the Society.
Peregallo's "Catalogue Général des Diatomées"	Purchased.

Mr. Nelson said that Mr. Lewis Wright's paper was a reply to papers by Lord Raleigh and Dr. Johnstone Stoney, in the "Pro-

ceedings of the Physical Society," on the aperture question. It would be a very valuable addition to the Library of the Club.

The thanks of the Club were unanimously voted to the donors.

Mr. Vezey said the members would, no doubt, be sorry to hear of the death of the oldest member of the Club—in point of age—Mr. Henry Perigal, whose death occurred on June 6th, in the ninety-eighth year of his age. He joined the Club in the year 1881, and was well known some years ago in connection with many of the Scientific Societies of London, and from the many contributions he made to the scientific periodicals. He had not done much lately in microscopy, his chief hobby being astronomy; but he always took a great interest in the proceedings of the Club, and was pleased to hear of all that was going on. Mr. Vezey said that during the past week he had received a letter from their member, Mr. C. J. Pound, who was now connected with the Stock Institute at Brisbane, in which he made reference to his work in connection with the mischief caused by ticks amongst cattle in the colony, which, amongst other things, were believed to produce the disease known as red-water. He said he had sent some specimens of the ticks referred to, but the packet had not yet arrived. Mr. Pound's note was then read.

The President said that a paper which Mr. Nelson had written on "The Evolution of the Microscope," Part 2, would be taken as read, and would appear in the Journal *in extenso*.

Mr. Earland read a paper " On *Orbiculina Adunca* F. et M."

The President believed that several of their members had worked at the Foraminifera, and if present they would, he hoped, favour them with some remarks.

Mr. Karop was afraid that the President was under a misconception as to there being a number of their members who had worked at the Foraminifera, for he feared that at the present time there were very few indeed who had done so. He believed Mr. Priest had done a little in this direction, but he hardly knew of any one else. Personally he felt very much indebted to Mr. Earland for bringing them this paper, for he had very little beside to put upon the agenda. They had the promise of a very extensive paper, but found that the cost of the illustrations required put this entirely beyond their means. Mr. Earland's paper dealt with a very interesting subject, and would be read with interest by all. He did not know very much about it, but

would like to ask whether the name of Foraminifera was not rather incorrect. He thought it had, no doubt, been given because the early observers found that, like the Nautilus, the shell was divided into separate chambers with foramina between them.

Mr. Earland said this was no doubt the case, but it had since become the popular idea that the name was derived from the outside perforations seen in so many of the species.

The President said he was very sorry he had made a mistake as to the workers in this particular direction; but he had been led to suppose that there were many because of the considerable number of slides which he had seen exhibited at their meetings and soirées. The way in which Mr. Earland had handled this subject led him, however, to suppose that it would engender a desire amongst the younger members of the Club to do something themselves in this direction.

The thanks of the Club were unanimously voted to Mr. Earland for his paper.

Mr. C. J. Rousselet read a paper on "Micro-cements for Fluid Cells."

Mr. Morland said he was not at all in favour of using any cement merely because it had the same name as one which had formerly been found serviceable, because he found that what was supplied at one time was quite different from what he got next. He therefore liked to know before he used a thing what it was made of. Mr. Rousselet had something in his paper about gold size, but he should like to know what sort of gold size, because he found that even this varied in its composition.

Dr. Measures said it always seemed to him that they should keep in mind the great principles involved in the use of any cement—(1st) that it was wanted to secure the contents against evaporation, and (2nd) to prevent the cover from moving. His experience was that they must prevent by all means the escape of the last trace of solvent from the cement employed, whether the object was mounted in balsam or in fluid, and to ensure this the best way was to cover the cement with another which was dissolved in a different solvent—gum damar was a good material when the solvent was benzole, and a spirit cement over that would prevent the escape of the last trace of benzole and be perfectly durable. He has some slides which were cemented

with gum damar and gold size overlaid with shellac and spirit cement, and these had remained good after a number of years. He had also some which had been sealed with Brown's cement, but this had failed. The first requisite was to get something which would not be acted upon by the fluid in the cell; and the next was to give this an overlapping layer of some other cement which was not acted upon by the solvent of the first.

Mr. Karop said he had a series of slides of Tipula preserved in glycerine, which were ringed with Miller's caoutchouc cement, which seemed quite good. Mr. Morland's idea was of course very good, but it would, he thought, be found rather difficult to make one's own cement in the small quantities required, especially such materials as gold size. Hollis's glue was good, and he believed this was made of caoutchouc dissolved in *wood* naphtha, *not* mineral naphtha.

Mr. Earland said he had recently received three slides, dated 1851, containing desmids, and the fluid in these was intact; they were sealed with what looked like gold size.

Mr. Nelson said he had some very large insect preparations, and none of these had ever burst through the expansion of the fluid. Another thing worth mentioning in connection with this subject was that he had been told by a mounter always to make the cover-glass a little concave, and then the changes of temperature would not be so likely to lift the cover when the fluid expanded, as the cover-glass would be able to spring sufficiently to resist the pressure.

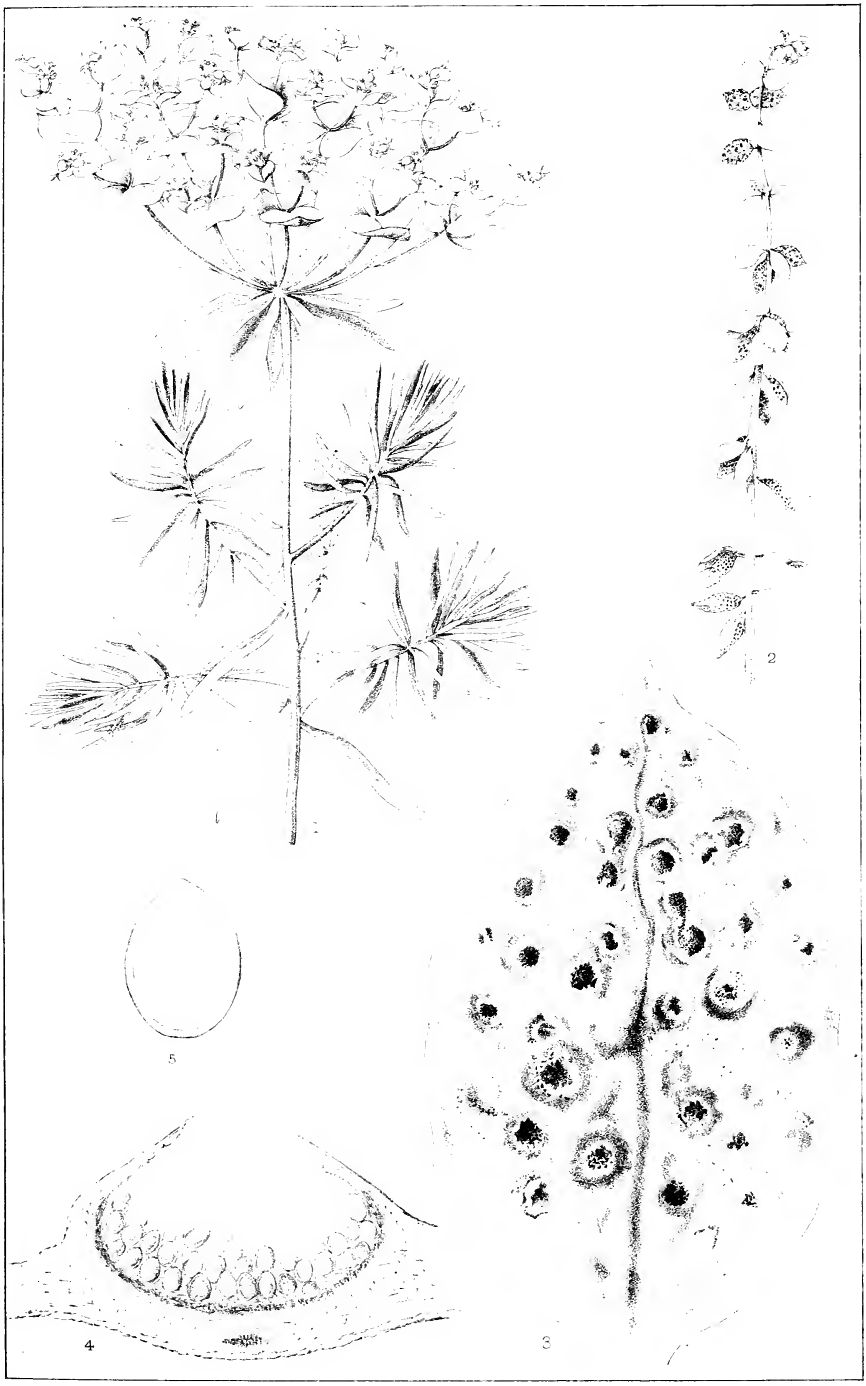
Mr. Hinton said all those which he had seen of this kind had an air bubble in them, but he did not think they were any the worse for this; no doubt it allowed of the expansion and contraction of the fluid in the cell.

The President thought they had had a practically useful discussion. About thirty years ago he belonged to a small microscopical society at Manchester, and the members used to practice mounting objects; but they got into very considerable difficulties with regard to aqueous fluids. Some few of their members, especially one man, however, seemed to have no trouble, and specimens which he mounted then were as good as ever at the present time. He thought that personal equation came in very considerably into the matter—one man failed whilst another seemed to know exactly how to do it without knowing why.

He thought Mr. Morland had hit the right nail on the head in saying that the cements sold under the same name were not always of the same composition, and therefore they might succeed at one time and yet fail at another with cement of the same name, although purchased from the very same place. He felt pretty certain that very much depended upon the ability of the person who did the mounting, as also upon the way in which the slides were mounted, and to what temperature they were afterwards exposed.

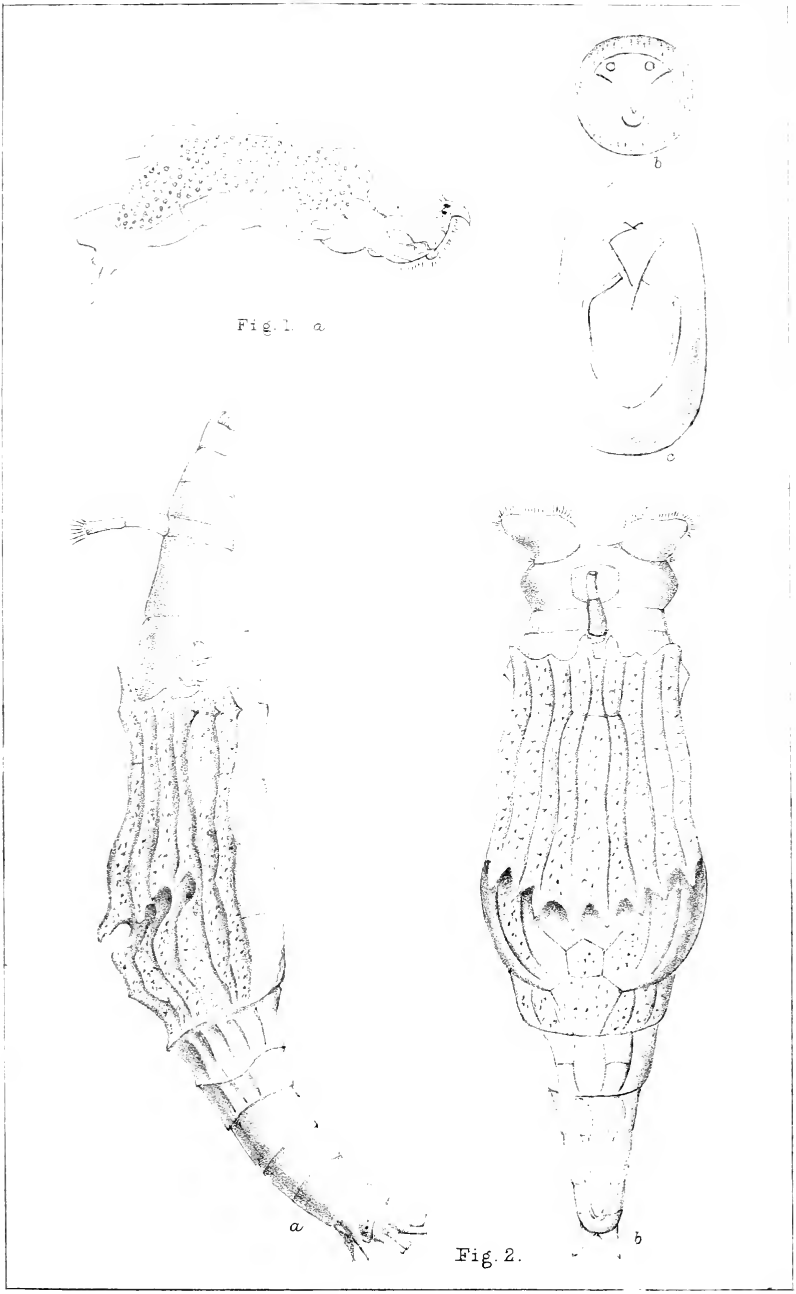
A vote of thanks to Mr. Rousselet was then put by the President, and carried unanimously.

The Secretary announced that their next ordinary meeting would be held on October 21st, and wished the members a very pleasant vacation.



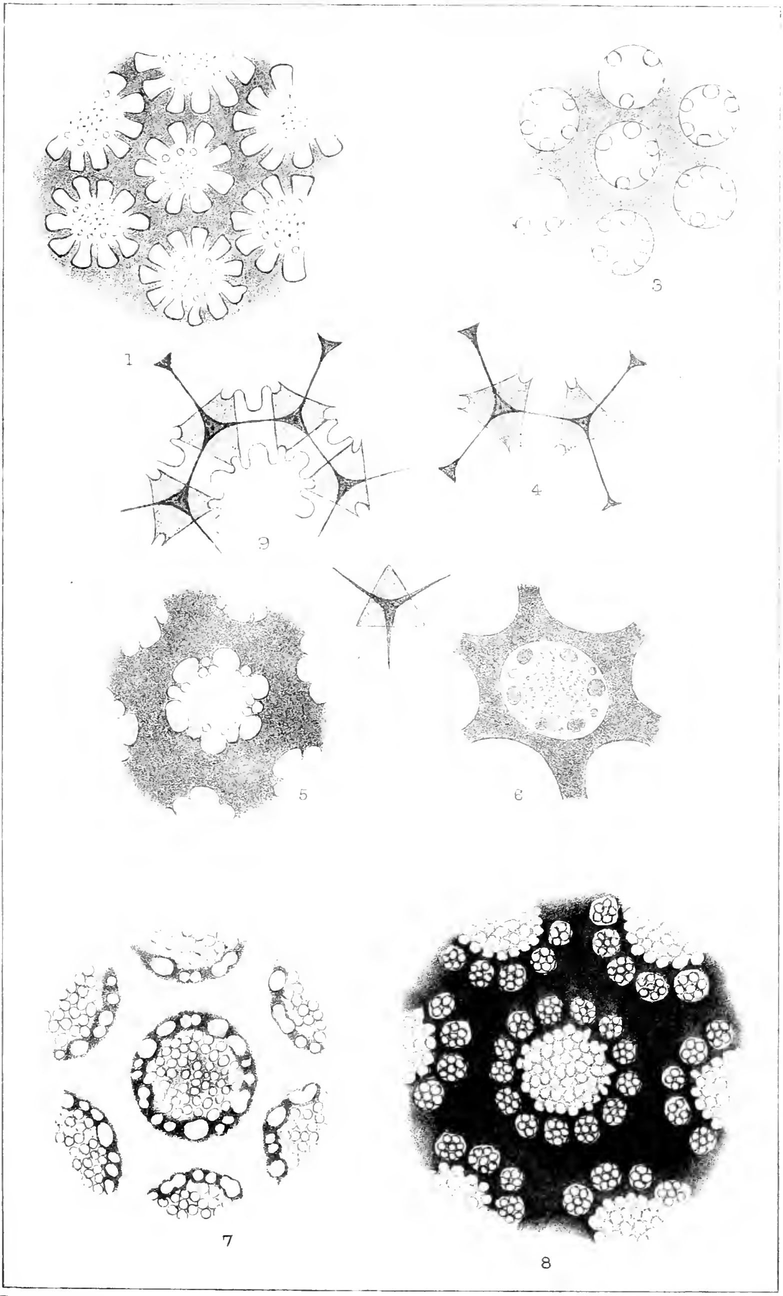
G.C.Karop del. West, Newman imp.

Euphorbia Cyparissias L.



J.E. Lord ad nat. del. West, Newman lith

Fig. 1. Taphrocampa nitida.
Fig. 2. Callidina cataracta.



D.M.M.Nelson del. West, Newman lith.

Coscinodiscus Asteromphalus.

The Q. M. C. Fungus Foray.

By G. Massee, F.L.S.

(*Read October* 21*st*, 1898.)

It was arranged that during the autumn of 1898 a fungus foray should be held in Epping Forest under the auspices of the Quekett Microscopical Club, but owing to circumstances over which mortals have no control this great idea was frustrated, the season being too dry, and all that could be effected by the enthusiastic party assembled at Chingford was to so direct their footsteps as not to be swallowed up by the yawning chasms in the ground caused by the extreme drought, partake of slight refreshment to compensate for wear and tear in endeavouring to effect the same, and return home with empty vasculums. The next suggestion made was a chat on what, under more favourable auspices, the material collected would have illustrated. This suggestion was carried out, and the following is a summary of the principal points alluded to.

Fungi were differentiated as a group before the evolution of terrestrial (dry land) vegetation, and as a combination of necessity, convenience, and gratitude, lived in the first instance as parasites upon various members of the group of plants from which they were evolved, the seaweeds or algæ. A small section, the conservative party, have retained this habit up to the present day.

All fungi are parasites in the sense of requiring organic food, some being satisfied with dead matter, others attacking living organisms; many are capable of utilising with equal satisfaction living or dead matter as food.

In primitive aquatic forms the entire fungus is buried in the body of the host on which it is parasitic, the one form of reproductive bodies, which are of sexual origin, and closely resembling those of the ancestral algal type, being liberated on the decay of the host, and dispersed by water.

The evolution of terrestrial vegetation afforded an opportunity for the extension in space of fungi; and the extent to which they

availed themselves of the opportunity may be estimated from the fact that at the present day no fewer than 45,000 species of terrestrial fungi are known, whose distribution is equal to that of the higher forms of vegetable life on the presence of which their existence depends, no fungus having deviated from the primitive parasitic mode of life.

Fossil wood from rocks belonging to the carboniferous period affords ample evidence of the presence of parasitic fungi belonging to the primitive type indicated above. Neither do the members of the animal kingdom altogether escape, unmistakable evidence of the presence of parasitic fungi in the remains of ancient corals having been recorded; and even at the present day various species of insects serve as hosts for highly evolved types of fungi.

In one of the earliest groups of terrestrial fungi, the Peronosporeæ, the evolution of a second form of reproduction was perfected, known as the conidial or summer form of fruit. The ancestral sexual fruit produced in the tissues of the host was retained without modification.

The conidial form of fruit is developed as follows. The members of the Peronosporeæ are parasitic on living plants, attacking more especially the foliage; the vegetative mycelium remains inside the host, and after ramifying and accumulating an amount of reserve material, gives origin to immense numbers of specialised branches, which either push through the epidermis or through the stomata into the air, and there produce myriads of conidia or asexually formed, very minute reproductive bodies.

The object of producing conidia outside the host was for the purpose of utilising the available terrestrial means of spore dissemination. In early times wind and rain would be the dispersive agents, and with the advent of groups of insects having a taste for nectar or being attracted by brilliant colours, we find groups of fungi, as some of the Ascomycetes—*Claviceps*, *Sclerotinia*, etc.—and all the Phalloideæ, offering the attractions of nectar, smell, and brilliant colours in various combinations, for the purpose of effecting through the unconscious agency of insects, the diffusion of conidia.

The conidial phase of reproduction in most fungi corresponds to what are popularly known as moulds and mildews, and all such were at one time considered as distinct species, each having its own generic and specific name.

The special function of the conidial form of reproduction is to enable the fungus to extend its geographical range; as already stated, the conidia are exceedingly minute, are produced in immense numbers, and in rapid succession during that period of time when the host-plant is in full foliage and active growth; are readily disseminated by wind, rain, insects, birds, and other agents, and are capable of germination the moment they are mature; consequently those that happen to alight on the foliage of a suitable host-plant enter its tissues, and within a few days form a new centre of disease from which conidia are liberated to continue the extension of the species.

As a rule parasitic fungi are only capable of growing on host-plants that are allied to each other; hence from the above account it can be readily understood how rapidly it is possible for a fungous epidemic to spread, more especially where numerous plants of the same species are growing in close proximity, as is the case with most cultivated crops. All fungous epidemics are due to the rapid spread of the conidial form of the fungus.

It is important that the significance of the conidial form of reproduction should be clearly understood, for although evolved very early after fungi passed from their primordial aquatic home and took possession of the dry land, and in the earliest forms to be considered as subordinate to the older sexual form of reproduction, nevertheless the acquisition of a second mode of reproduction proved to be a step in the right direction, and has continued to become more and more highly evolved, until finally in the highest and newest types of fungal evolution we find the conidial mode of reproduction alone remaining, the sexual form of fruit having been completely arrested.

Returning to the Peronosporeæ: after the conidial form of the fungus has run its course, and the infested leaves or other portions are killed by the fungus and have fallen to the ground, the mycelium in their tissues continues to grow, and gives origin to numerous sexually produced reproductive bodies called oospores from their mode of origin; also termed resting-spores because they require to remain in a resting or passive condition for some time before they are capable of germination.

During the winter the leaves containing resting-spores may decay and completely disappear, but the oospores remain unchanged on the soil until the following spring, when they

germinate and give origin to minute conidia which are distributed by wind, and those that happen to be deposited on the young leaves of a suitable host-plant germinate at once, enter the tissues, and within a few days give origin to the conidial form of reproduction once more.

The function of resting-spores is to enable the fungus to tide over that period during which the host on which it is parasitic is not in a condition of active vegetation.

Following the Peronosporeæ in the sequence of evolution, we come to the enormous group of fungi, in the broader sense known as the Ascomycetes; and throughout the assemblage conidial, and what may be termed the sexual methods of reproduction are present. However, in the Erysipheæ, one of the oldest sections of the Ascomycetes, the resting-spore phase is still the result of a sexual act, whereas in the Sphæriaceæ and other sections, although the fruit producing resting-spores is morphologically similar to that of the Erysipheæ, it is in reality asexual in origin; traces of the sexual organs are present in various sections, but are functionally effete, and in others have become quite rudimentary.

Finally, in the most modern and highly differentiated group of fungi, the Basidiomycetes, there is no vestige remaining of the originally sexual mode of reproduction, the continuance of the species depending entirely on the production of asexual conidia, aided by various vegetative methods whose gradual evolution progressed during the period of decadence of the sexual method of reproduction.

The last-mentioned group, including the well-known and universally distributed "toadstools," mushrooms, puffballs, etc., illustrates the highest phase of evolution of the conidial form of reproduction; which, contrasted with the delicate mould-like form first evolved, shows a remarkable amount of differentiation, being always comparatively large, often gigantic, and sometimes woody and perennial.

Among vegetative modes of reproduction two forms are worthy of special mention. Sclerotia are solid aggregations of mycelium of variable size and form, depending on the species to which they belong. In New South Wales, Victoria, and Queensland, certain irregularly globose bodies varying in size from a cricket ball to that of a child's head, dark brown externally, whitish and marbled

within, and of a woody hardness, are fairly abundant in the soil in certain districts, and are known locally as "native bread." Berkeley, recognising the fungous nature of these productions, bestowed on them the name of *Mylitta australis*, but was unable to indicate their affinity owing to the absence of reproductive organs. Quite recently these structures have been proved to be the sclerotia of a fungus called *Polyporus mylittæ*, Cke. and Mass. Many other species of fungi produce sclerotia, some of which are not larger than a pin's head. Sclerotia are formed from the vegetative mycelium of the fungus, and functionally are of the same value as the various kinds of resting-spores, remaining for a time in an unchanged condition—sometimes for many years—and eventually giving origin to a new plant, either directly, or from mycelium or conidia, which are first formed.

Rhizomorphs differ from sclerotia in being long, cord-like bodies formed also from the mycelium. These structures radiate from the point of origin in all directions in the soil, at a depth of a few inches below the surface. When the tip of a rhizomorph comes in contact with the root of a tree it penetrates the tissues, where a dense mycelium soon forms, feeding upon and eventually killing the tree, after which the above-ground fruit of the fungus is developed, new rhizomorphs meanwhile radiating from the new centre of development in search of other victims. *Armillaria mellea*, a very common British "toadstool," spreads rapidly by means of subterranean rhizomorphs, and proves very destructive to various species of forest trees.

Notes on a Group of Marine Microscopic Vegetable Organisms invading Calcareous Organic Remains.

By W. H. Harris.

(*Read November 18th, 1898.*)

Plates 9 and 10.

Introduction.

For many years past I have devoted considerable attention to the study of the Foraminifera, and dredgings from many parts of the world have come under my observation. Very early in the course of my investigations I observed that these organisms, together with fragments of molluscan shells, sponge spicules, and countless other kinds of organised material presented various conditions of preservation. The brilliancy of a recent test, or lately cast-off shell, immediately attracted my attention, and in contrast to this, those which had been discarded for some length of time; the latter appeared dull, the surfaces were very obviously defaced and sometimes discoloured, channels and variously-shaped cavities were present, their substance was invaded by something prejudicial to their preservation, and disintegration had commenced. Thus, early in my studies, I was led to inquire into the nature of the agency which caused this breaking-up. It was clear that simple chemical action was not the cause; there was a tolerable uniformity in the size and form of the excavations, and in some instances they were connected with each other by channels of extreme minuteness, and of almost uniform diameter; such appearances would scarcely result from inorganic chemical action.

There remained, then, the alternative—the appearances were the result of organic action. Naturally I became anxious to know as much as possible about the little organisms whose destructive work I could so plainly see, but the way in which it was performed I was even unable to conceive.

About this time I was corresponding with one of your members,

Mr. B. W. Priest, and when in town I occasionally called upon him; it was on one of the latter occasions, I think, that a conversation took place regarding the organisms in question, and subsequently he sent me a copy of a paper read by Mr. J. G. Waller at a meeting of your Society held on March 28th, 1884, entitled "On Parasitic Vegetable Organisms in Calcareous Particles of the Gabbard and Galloper Sands." This paper was a revelation to me, and I at once decided to endeavour to verify Mr. Waller's work, by seeking for specimens of the species he had described amongst such British material as I then possessed. The first material worked over was procured from Morte Bay, and a careful search was rewarded by the finding of the bulk of the forms figured and dealt with in the paper I have referred to; and I had the further pleasure of discovering one or two forms which were either absent from the Gabbard material, or if present had apparently not been discovered.

As opportunity offered I set aside such pieces of shell as appeared to me to be worthy of further investigation when time would permit, and it was not until about three years since that I decided to systematically work over the various samples of material in my possession with the object of discovering new forms and of learning something as to the distribution of these organisms in both space and time. The result has been a tolerably large collection of very curious and extremely interesting specimens of this form of life.

A provincial worker labours under difficulties from which the dwellers in the Metropolis are exempt: rarely can he meet a kindred mind to exchange ideas with, even when working on the most commonplace subject, still less can he hope to do so when he attempts more abstruse problems. Being anxious to know if any work had been done which extended the knowledge of this subject further than Mr. Waller had carried it, I addressed a note to that gentleman briefly detailing what I had done, and asking if he knew of any literature in the English language upon the subject, and if so where it was procurable. He very kindly answered my inquiry in the negative, and urged me to draw up and send him an account of what I had noticed, when he would bring it forward at one of your meetings. This was a courtesy I never anticipated, but which I fully appreciate, and I can only hope that the members will not think I have been

instrumental in wasting their time, and possibly exhausting their patience.

Apart from extending our knowledge of a few species, I am painfully aware of the small amount of information I am able to impart; but, after all, pioneer work must consist in discovering, recording, and roughly classifying. When sufficient information of this nature has been accumulated, a foundation will have been laid to assign the place in nature this group of organisms should occupy. I lay no claim to botanical knowledge of any kind; it would therefore be presumption on my part to offer an opinion on this point. All that any one in my position should do is to state as many facts as he has been able to obtain, to be cautious when making statements that they may not be liable to misinterpretation, to be sure those made shall be capable of being demonstrated, and above all to avoid getting into the foggy atmosphere of premature theory. Thus a foundation may be laid for other investigators, and, by slow degrees, a subject which at first appeared hopelessly obscure may be elucidated, and ultimately assume proportions never expected.

It will be observed I have not adopted the idea of Parasitism in the title to these notes. Frequently that term is very loosely applied, and its full consideration would here be out of place; but I should give some reasons for not using it. I therefore content myself with defining a Parasite as an organism which is parasitic upon other organisms belonging to the same natural kingdom, deriving its sustenance from its host to the detriment, or absolute destruction, of the latter. Unless we confine ourselves within these limits difficulties present themselves from which escape is impossible. These vegetable organisms evidently find a habitat as suitable to their requirements in the mineral remains of marine animals as common weeds do in the soil of our gardens, yet we do not look upon the latter as parasites, but merely as invaders.

Apart from these objections, so far as my investigations have gone, I have no direct evidence to offer that these plants attack the shells, spicules, etc., while they form parts of the living animals; the slight evidence I have to offer is distinctly opposed to the idea of their being parasites. I have had several collections of dredgings, of which fine mud formed by far the larger proportion; in one case a pound of uncleaned material from Pekalongau gave about a quarter of an ounce of organic

remains, in which I discovered only one of the vegetable organisms. Again a half-pound of dredgings from Batavia (Java) gave only a few grains of suitable material, in which but two fragments were deemed worthy of preservation. Java sea dredgings outside the limits of fine mud deposit simply teem with the little plants. Dredgings from Cebu, Philippine Islands, when taken from the Hyalonema ground at a depth of 120 fathoms contain a smaller percentage of mud than the preceding, forming however a large proportion of the bulk, and the vegetable organisms are very sparingly represented, while tolerably pure sand from a beach in the same locality affords a plentiful supply.

My impression is that the mud protects the fragments of shells, etc., from the attacks of the plants.

I have several slides of sponge spicules, prepared from specimens dredged in a living condition, but not a single example of the little plants can be detected therein.

I have a note of a very interesting case, but unfortunately I appear to have lost the specimen. The *concave* side of a shell was bored for some depth by a boring mollusc, the shell was invaded by the vegetable organisms, and one plant took the direction of the hole; it then descended and ascended its sides, passing on as though no obstruction had occurred. This is a curious example of lack of judgment on the part of the boring mollusc, but I cannot help feeling much obliged to it for assisting me with evidence confirming the view I have taken that the cast-off shell was invaded by the plant subsequent to the excavation by the mollusc.

Until proof of the incorrectness of my theory can be adduced I am disposed to regard these as organisms finding a suitable habitat in dead organised material: hence I use the term "invading" in preference to "parasitic."

Bibliography.

The following list of literature on the subject of this paper is as far correct as I have been able to ascertain. Nearly all the papers are scattered through various reports of scientific societies, for copies of which I am indebted to my private friends, and also to the excellent work on Fossil Plants, by A. C. Seward, M.A., F.G.S., Cambridge University Press, 1898, which has just been published.

I have arranged the list in chronological order, and it may prove useful to subsequent investigators of the subject:—

1852-54. QUECKETT, J. "Lectures on Histology," vols. i. and ii. London.

1855. ROSE, C. B. "On the Discovery of Parasitic Borings in Fossil Fish-scales." (*Trans. Mic. Soc.*, N.S., vol. iii., p. 7.)

1859. KOLLIKER, A. "On the Frequent Occurrence of Vegetable Parasites in the Hard Structures of Animals." (*Annal. Mag. Nat. Hist.*, vol. iv. (3), p. 300.)

1876. DUNCAN, P. M. "On some Unicellular Algæ, parasitic within Silurian and Tertian Corals, with a notice of their presence in Calcolina Sandalina, and other Fossils." (*Quar. Jour. Geol. Soc.*, vol. xxxii., p. 205.)

1881. MOSELEY, H. N. (*Challenger* Reports, *Zoology*, vol. ii., p. 30.)

1884. WALLER, J. G. "On Parasitic Vegetable Organisms in Calcareous Particles of the Gabbard and Galloper Sands." (*Jour. Quek. Mic. Club*, vol. i., Series II., p. 345.)

1888. PRIEST, B. W. "On some Remarkable Spicules from the Oamaru Deposit." (*Jour. Quek. Mic. Club*, vol. iii., Series II., p. 254.)

1888. BORNET, E., and FLAHAULT. "Note sur deux nouveaux genres d'Algues Perforantes." (*Jour. Bot.*, vol. ii., p. 161.)

1889. BORNET, E., and FLAHAULT. "Sur quelques plantes vivants dans le Test Calcare des Mollusques." (*Bull. Soc. Bot. France*, vol. xxxvi., p. 167.)

1892. BATTERS, E. A. "On Conchocelis, a New Genus of Perforating Algæ." (*Phycological Memoirs*, London, p. 25.)

1892. ETHERDIGE, R., Junr. "On the Occurrence of Microscopic Fungi, allied to the Genus Palæachyla *Duncan* in the Permo-Carboniferous Rocks of New South Wales and Queensland. (*Rec. Geol. Survey, N.S.W.*, Part III., p. 95.)

Their Place in Nature.

The exact position in the vegetable kingdom occupied by these organisms has not, so far, been definitely determined, but they have been placed among the Thallogens.

This sub-class has three alliances—viz., Algales, Fungales, and Lichenales. These include such forms of plants as are asexual, or flowerless, without proper stems or leaves; they are mere masses of cells. Their reproduction is by a special disintegration and solidification of some part of their tissue, spontaneously effected.

The following extract from a recently published work by A. C. Seaward, M.A., F.G.S., entitled "Fossil Plants," may be advantageously introduced as descriptive, viz.:—

THALLOPHYTA.

I. Peridiniales.
II. Cocospheres and Rhabdospheres.
III. Schizophyta.

1. Chizophyceæ (Cyanophyceæ) gervanella, zonatrichetes.
2. Schizomycetes. Bacteria.

"In this group are included small single-celled plants of an extremely low type of organisation, in which reproduction takes the form of multiplication by simple cell division, or the formation of spores. In many cases the members of this sub-class contain chlorophyll, and associated with it a blue-green colouring matter; such plants are classed together as the Blue-green Algæ, Cyanophyceæ, or Schizophyceæ. Others, again, are destitute of chlorophyll, and may be conveniently designated Schizomycetes. Seeing how close is the resemblance and relationship between the members of the sub-class, it has been the custom to include them as two parallel series under the general head Schizophyta, rather than to incorporate them among the Algæ and Fungi respectively."

Under the head Cyanophyceæ mention is made of the organisms which bore into and perforate shells of molluscs, and it is stated that "the recent genus Hyella" has been created, associating the names of Bornet and Flahault therewith; but no description is given of the forms dealt with.

There is abundant evidence of great variation among the members of the group; with more complete knowledge it is possible the number of genera may be increased, and probably all the forms capable of invading organised mineral remains may ultimately be elevated to the dignity of a division of the Schizophyta to be created for their reception.

General Description.

These vegetable organisms are chiefly found in fragments of Molluscan shells and Foraminifera, more sparingly in calcareous spicules and particles of Polyzoa; occasionally they may be detected in spines of Echinoderms.

Sometimes the superficial layers of one or both sides of the shell are alone infested with the plants; in other cases they penetrate to a considerable depth, or may actually perforate the shell, commencing their growth on one side and passing, either obliquely or directly, through to the opposite side. In the multiplication of individuals of some Lacunæ, I have observed an alternation from one side to the other; but however they behave in this respect there appears to be one essential condition—this is their constant demand for contact with the surrounding water. They appear to satisfy this in more ways than one. They may erode the shell at the point of entry until quite a large cavity of irregular shape is formed; these may be repeated at intervals, and ultimately becoming confluent, leave the surface of the shell channelled with the form of the plant. Or they may produce short tubular processes equal in diameter to the parent filament, and leading directly to the surface of the shell. In some species these openings are placed very closely together and present a uniform appearance, in others they occur more sparingly. Other species produce very fine hair-like processes upon that portion of filament which lies nearest to the surface of the shell; innumerable ducts are thus formed to satisfy the requirements of the organism. In other species the method of meeting the demand for contact with water is not apparent, as no specialised organs exist, nor can any apertures be seen; these are rather deeply immersed in the containing fragment, and further investigation is necessary to solve the mystery. In other species, again, which occupy a more superficial position, the explanation is tolerably easy, as some of these organisms have the power to partially disintegrate the enclosing body beyond the limits of the filaments; this partial breaking-up of the surrounding parts sometimes presents a cloudy appearance following every detail of the plant's growth; thus innumerable minute fissures surround them, which efficiently supply the needs of the organism. I have a specimen which has been mineralised, and subsequently decalci-

fied; a fringe of mineral matter surrounds the outline of the plant and is a very satisfactory exposition of this method of adapting itself to its environment.

Whichever form of communication the various species may adopt, there can, I think, be very little doubt as to the purpose such communications serve in the economy of the plants. Their function appears to me to be threefold: primarily for the imbibition of water necessary to the growth of the organism; secondly, for the escape of gas which must be evolved during the process of excavation; thirdly, where organised apertures are present, as excretory ducts for the liberation of reproductive bodies which form within the filaments.

I am not aware that very much more than the foregoing is known regarding the physiology of these plants. Experiments in this direction could be prosecuted only by any one having access to a marine laboratory, and even then it would be quite impossible to reproduce the conditions under which some of the species appear to flourish. We are therefore obliged to confine our investigations to the cavities they have eroded, for the remains which are present are of such extreme tenuity, so utterly devoid of structure, and so persistently refuse to respond to the action of reagents, that no progress can be made. I am fully alive to the fact that mere external form unaccompanied by structural description may be misleading, but unfortunately it is the only means at present known whereby species may be discriminated. I have, therefore, endeavoured to minimise the errors such a course is open to by collecting many specimens of each form, not only from the dredging in which the original was found, but also from material from widely separated areas. When, therefore, certain characteristic forms are persistent I think we are justified in regarding them as indicative of specific value, at least until more reliable means are known to guide us to a safe conclusion.

By a slow process of decalcification their remains can be disengaged from the shells; but beyond obtaining a very thin pellucid film agreeing exactly with the conformation of the cavity no results have accrued by so doing. They are exceedingly fragile, and break up into an irrecognisable mass with the slightest pressure.

Sometimes the cavities are filled with a yellowish-brown plasmic substance; in some specimens this has a tendency to

become separated into little detached masses, and if the specimen is one of the filamentous description these detached masses can be seen to be still further breaking up until small globular or subglobular bodies are found, which are probably reproductive elements of the nature of spores; these ultimately escape through the perforations, the majority of specimens being devoid of these bodies. The little flask-shaped cavities are also occasionally packed with similar bodies, either colourless or of a rich amber tint.

The multiplication of individuals of the last-named division can be very easily studied if uncrowded fragments are selected for the purpose. The process appears to be as follows: the reproductive body having found a lodgment upon a piece of shell, burrows into its substance; after the perfect flask-like form is assumed, very fine filaments are produced from the bottom or sides of the globular portion of the organism, sometimes extending for a considerable and at other times for a comparatively short distance. I am disposed to think this feature has a specific value, which further investigation may possibly reveal. Whatever distance they traverse the shell, their tendency is to reach its surface; and as soon as this occurs the growth again plunges into the shell, a duplicate flask is formed, and the process is repeated until the fragment is riddled with the cavities thus formed. One feature which appears to be constant is that the secondary cavities always occur at a point very slightly removed from the distal end of the filament.

Frequently both sides of a fragment of shell contain specimens of the same species of the filamentous kinds; among the robust varieties these are probably produced by the growth of the organism around the edges of the fragment, or they may plunge through its substance and reappear on the opposite side. I do not remember having met with a single example of multiplication of individuals taking place on the same system as observed among the Lacunæ; I am therefore disposed to think they originate from a spore-like organism and not by a vegetative process.

The margins of the fragments of shells are frequently crowded with forms in their early stages of growth, the position apparently offering suitable lodgment for and protection to the reproductive bodies until growth has commenced. In many instances the fracture has been caused by the erosion of the shell by the plant;

the remains of the cavity may be plainly traced, agreeing with the contour of the fragment; from this cause the difficulty of ascertaining the size robust species may attain is increased.

In some specimens the filaments are tolerably uniform in size throughout their entire length; others vary, alternately becoming small and large; others are large for a greater or less distance, then suddenly become small and continue so to the boundary of the particle.

I have noticed it is easy to associate distinct forms when in close proximity, which then convey the notion of a vesicular body arising from the filament, and should spores be present in the former the illusion is complete. But this appearance may arise in one of two ways: the filament of, say *Achlya perforans*, may approach the neck-like portion of, say *Lacuna globosa*, until they become nearly confluent, or the germ of the latter may enter the perforation of the former, and commence its growth from *within* the empty filament; the result is practically the same in either case—a false impression is created. Moreover, the false images these plants give rise to, owing to the different planes at which they locate themselves within the particles of shell, etc., provide a fruitful source of error.

That certain species are provided with processes which serve the office of reproductive organs I am convinced; but in the majority the production of spore-like bodies appears to be accomplished by the simple breaking up of the plasmic matter within the larger parts of the filaments.

The search for special organs of reproduction has strongly impressed me with the necessity for seeking isolated specimens in order to avoid incorrect notions regarding this phase in the life-history of the organisms.

There is a feature which appears to be pretty constant among the majority of species which may be referred to—viz., their habit of not becoming confluent: no matter however thickly crowded together they may be, they persistently avoid contact with each other. I have observed four filaments pursuing a parallel course divided by partitions of shell not wider than the three-thousandth part of an inch, and I once saw an example (unfortunately lost) of a filamentous form similarly avoiding the bulbous portion of a *Lacuna globosa* for more than half the diameter of the latter, before it passed on in its original course. The cause of this

avoidance of each other's paths may be that they extract from their mineral habitat, beyond the limits of the plant, an element necessary to their development. I have previously shown, on the evidence of a decalcified mineralised specimen, that they are capable of fracturing the containing material beyond the actual limits of their growth, and that would favour this view.

The avoidance of each other deprives us of the idea of anything approaching conjugation in such species. But this characteristic is not universal throughout the group, for such species as grow in small tufts erode the shells into comparatively deep pits by the branches coalescing towards the central point; and in another instance—viz., *A. reticulata*—the most prominent feature is the beautiful net-like appearance of the plant caused by the coalescence of the branches which it so freely produces.

Selective Powers.

There are indications, I am disposed to think, that the organisms display a partiality for certain material in the selection of their habitat; nor need this be matter for surprise, as all animated nature exhibits the same phenomenon. It would, indeed, be a strange departure from a natural law if they deviated from the rule which governs the better-known classes of the animal and vegetable kingdoms.

I have stated that these plants invade Foraminifera; when, however, a critical examination is made it becomes evident that they do not indiscriminately attack the entire order, but that they exhibit a decided preference for the members of the hyaline group; their invasion of the porcellaneous division is exceedingly rare. I have occasionally met with a few very minute specimens of Lacunæ in different species of the sub-family Miliolinæ, and a small, undetermined, branching species in the tests of Orbitolites. Beyond these I have no record.

The hyaline species are attacked in different degrees. Thus, the tests of *Operculina complanata* are frequently crowded with various species; *Amphistegina lessonii* and *Cycloclypeus guembelianus* more sparingly, still less so the tests of Textularia, and some of the sub-families of the Lagenidæ and Rotalinæ. My record for the Globigerinidæ consists of a few filaments of an undetermined species.

Entomostracan valves are plentiful in some dredgings, but for

some reason they are very rarely invaded by the plants, although they may be abundantly represented in other remains contained in the same gathering. One valve only has been thought worth preserving.

But evidence of partiality may be adduced tending to show that certain species select particular layers of shell for their habitat; fragments of shell may be met with which consist of two or more distinct laminæ of decidedly different structure and colour: such fragments are selected by *Achlya gracilis* and *A. flexuosa.* These plants spread superficially through the colourless, nacreous layer; they give off short branches which terminate in variously-shaped bulbous cavities; these plunge vertically into the shell, but never go beyond the limits of this particular layer. Other branches are produced which pass through the entire thickness of the shell; they are simple unbranched filaments entirely unlike the plant from which they arise. *Ranunculus aquatilis,* with its two forms of aërial and submerged leaves, is certainly not more remarkable in this respect than is this tiny organism.

In such a piece of shell I once had a specimen of *Varneia villosa*; it was situated about equidistant from either surface; by applying pressure with a needle I was fortunate in causing the two layers of shell to separate. I found the plant was wholly confined to one of these, and although the newly-exposed surface of the portion of shell containing the plant was eroded, no trace of its having penetrated to the second lamina could be detected.

Composition of Shells.

Any one who devotes any study to dredgings cannot fail to be impressed with the different appearances the fragments of molluscan shells present; from the highly prismatic shell of the Pinna to the porcellaneous foraminifer with its homogeneous composition, every gradation of structure may be obtained; thus they may be fibrous, laminated, horny, or glossy and translucent—in lustre they may be dull or nacreous.

The animal matter present also varies chemically, as well as in the method of its employment in the building of the shell.

In porcellaneous shells the animal matter consists of a small quantity of soluble gelatine; in nacreous shells it is albuminous; if the latter are immersed in very dilute hydrochloric acid they

leave a delicate membranous or cartilaginous residue, practically the remains of the mantle, but if a porcellaneous shell is similarly treated it will be entirely soluble. It is quite possible that the structure and chemical composition of shells may exercise a very important influence upon the vegetable organisms, not only as regards their development, but also the organic remains they invade.

I am not aware whether any work based on the following lines has been done in regard to molluscan shells and spicules. I find in the Report on the Foraminifera dredged by H.M.S. *Challenger* during the years 1873-76 by my late friend Mr. H. B. Brady, that an attempt has been made to analyse certain species of that order. The work "with two or three exceptions" was done by Dr. C. R. A. Wright, F.R.S., of London, and Mr. J. T. Dunn, M.Sc., of Newcastle-on-Tyne, and I feel sure no apology will be necessary for its reproduction.

ANALYSIS OF ORBITOLITES COMPLANATA, VAR. LACINIATA.

	I.	II.	III.	IV.
Silica	0·58	0·3	0·14	0·11
Carbonate of Lime	86·46	88·2	88·74	87·91
Carbonate of Magnesia	12·52	8·8	9·55	10·50
Alumina, with Phosphates of Lime and Magnesia	—	2·7	—	—
Alumina and Ferric Oxide	0·68	—	—	—
	100·24	100·0	98·43	98·52

	Amphistegina Lessonii.	Operculina Complanata.
Silica	0·3	0·2
Ferric Oxide	trace	0·1
Alumina, with Phosphates of Lime and Magnesia	1·95	1·3
Carbonate of Magnesia	4·90	4·8
Carbonate of Lime, with a little organic matter	92·85	93·6
	100·0	100·0

The former table refers to the porcellaneous division, in which the vegetable organisms are scarce; the latter to the hyaline group, in which they are very well represented.

Contrasting the two sets of tables, the chief difference appears to be an excess of carbonate of magnesia, with a corresponding diminution of carbonate of lime in the porcellaneous as compared with the hyaline tests.

Unequal Development.

Closely connected with the chemical constitution of organic remains is the question of unequal development of individual plants of the same species. Specimens collected from the same dredging will vary considerably, not only in the size of the mature plant, but in the diameter of the filaments. I fear that without carrying out a close analysis of such fragments as present extreme cases of development, no satisfactory conclusion can be arrived at. By no means does it follow that, because the fragments are contained in one dredging, they were built up under precisely the same conditions. Currents will transport material enormous distances; and this opens the questions of depth, pressure, temperature, and action of light, all probably exercising their influence in different degrees upon the constituents of the organic remains.

Starvation occurs in ocean depths, as well as on the land. Permit me one quotation from Mr. Brady's Report, page 131, on this point:—"In brackish water, where the supply of earthy salts in solution is smaller than in the open sea, the chemical and physical characters of the shells of such species as survive the changed conditions are considerably modified. They become by degrees less calcareous as the water grows less saline, until eventually a point is reached at which the investment is little more than a chitinous or horny membrane, strengthened by the incorporation of minute silicious grains, but containing so little carbonate of lime that it is scarcely altered by treatment with acids.

"A still more remarkable modification occurs in specimens from the abyssal depths of the North Pacific explored by the *Challenger* cruise. A few Miliolæ, from soundings taken at a depth of 3950 fathoms (about four miles and a half), scarcely distinguishable in form from young thin-shelled specimens of a common littoral species, were found to be unaffected by treatment

with acids; and upon further examination it became apparent that the normal calcareous shell had given place to a delicate, homogeneous, silicious investment."

The material I had from off Bird Island, Great Barrier Reef, Queensland, was remarkable for the thinness of the tests of the porcellaneous foraminifera and the fragments of the molluscan shells it contained, clearly indicating a struggle with the coral for the mineral salts. It is therefore not unreasonable to assume that under certain circumstances the animals may be deprived of some portions of the constituents of their hard parts, and that the effect of this is shown in the vegetable organisms by their diminutive development; consequently I have been led to the conclusion that measurements are to some extent valueless as a means of identification of species.

Distribution.

The geographical distribution of these organisms appears to be world-wide. Wherever suitable material has been obtained representatives of the group have been discovered.

Some species appear to be cosmopolitan and plentiful; others, although widely distributed, are nevertheless more restricted to particular areas, while others again may be comparatively local.

The British coasts, if carefully worked, would, I believe, yield a list equal to any area of similar extent in any part of the world.

The table given on page 154 is a slight contribution to our knowledge of the geographical distribution of the group.

The bathymetrical distribution is probably influenced by temperature. From the table given on page 155 it will be observed that from the littoral down to 50 fathoms twenty-nine species occur; from this point to 450 fathoms the number is reduced to nine species.

According to the tables of ocean temperature in the *Challenger* Reports, the greatest decrease takes place from the surface down to 500 fathoms. From this point to the greatest depth the decrease per 100 fathoms is considerably less. An extract from the table St. Thomas to Bermuda will afford an illustration. The surface temperature is given as 75·5°; at 500 fathoms it is 45°, a diminution of 30·5°, or an average of 6·1° for each 100 fathoms. The next 1,000 fathoms a diminution to 37·5° takes place, or an average of 0·75° per 100 fathoms.

Of the geological distribution of these organisms I have little information worth recording. They are plentiful in material from the Miocene deposits of the west coast of New Zealand, Belgium, and France; also in Calcare grossier material belonging to the Middle Eocene period. In a slice of carboniferous limestone taken from the Polyzoa bed at Clifton, Bristol, I have detected two short fragments of filaments which closely resemble the organism known as Saprolegnia, beyond which I have no further record.

Conclusion.

Although no one can be more conscious of the many imperfections and shortcomings of this paper than myself, still I sincerely hope some allowance will be made on account of the many difficulties the subject presents—difficulties to be thoroughly understood and duly appreciated only when real work is attempted.

If I have been instrumental in making any addition to the general knowledge of the subject, or other workers are thereby induced to take up the study of these interesting organisms, I shall conclude that my work has not been undertaken in vain.

Descriptions of Species.

Genus **Lacuna.**

Lacuna fistulosa.—A small irregular-shaped species, occupying the superficial layers of the fragment; the portion of cavity nearer the surface is beset with numerous short, stout, tubular processes, which reach the surface of the containing fragment; sometimes tolerably large portions of shell are eroded, exposing the under side of the organism.

They occur as isolated individuals, and are rare.

My specimens were obtained from Cebu, Philippine Islands, 20 fathoms, and Auckland, N.Z., littoral deposit. Plate 9, Fig. 1 × 280.

Lacuna pubescens.—This is a robust flask-like form, thickly beset with moderately long appendages, which give the organism a hairy or fleecy appearance.

There are one or two rather long filamentous processes given off from the bulbous portion in my examples adorned in a similar manner, but until further specimens can be found from other localities this cannot be stated to be a constant feature.

Mr. Waller informs me he had met with this species and had sketched it, but did not name it or describe it.

Undoubtedly it is a rather rare form; the only specimens met with by me were found in material from Java Sea and Macassar Straits, both 45 fathoms

GEOGRAPHICAL DISTRIBUTION TABLE.

	Morte Bay.	Whitesand Bay, Cornwall.	Barmouth.	Kenfig Pool, Bristol Channel.	*Challenger* Station, No. 23.	*Challenger* Station, No. 122.	*Challenger* Station, No. 33.	*Challenger* Station, No. 172.	*Challenger* Station, No. 174.	*Challenger* Station, No. 192.	*Challenger* Station, No. 187.	Aden.	Ceylon.	Barbadoes.	Batavia.	Pekalongua.	Java Sea.	Macassar Straits.	Cebu, 20 fathoms.	Cebu, 120 fathoms.	Cape Agulhas.	Auckland, New Zealand.	Great Barrier Reef.	Lagos Bay, South Australia.	King George Sound, South Australia.
Lacuna globosa	*	*	*	*	*			*			*	*		*					*				*	*	
,, ampullæformis ...	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*		*	*		
,, radiata	*	*	*	*								*						*	*		*	*			
,, radicans	*	*																							
,, sporangifera ...	*	*	*	*				*			*	*					*	*	*	*	*				
,, pubescens																	*	*							
,, fistulosa																			*			*			
,, incerta																	*	*							
,, moniliformis ...	*				*														*						
Achlya perforans	*	*	*	*	*	*	*	*				*	*				*	*	*	*	*	*			
,, nodosa						*	*		*	*				*			*	*	*			*			
,, villosa	*	*		*	*							*					*	*			*	*			
,, gracilis	*		*		*					*		*							*		*	*		*	
,, flexuosa	*	*						*																	
,, radiata								*						*			*	*					*		
,, tortuosa		*	*														*	*	*						
,, reticulata																	*	*							
,, flabelliformis ...											*			*			*	*					*	*	
,, minutula		*									*	*			*		*			*			*	*	*
,, cervicornis								*			*			*			*							*	*
,, porosa		*	*											*					*			*			
,, simplex	*	*									*							*							
,, quadradiata		*																				*			
,, do. var. villosa ...		*		*																					
,, fasciculata		*						*			*		*		*				*			*	*		
,, articulata		*						*			*														
,, aculeata														*											
Saprolegnia	*	*	*	*	*	*	*	*		*		*						*	*	*	*	*			
Varneia villosa	*	*	*														*	*	*			*	*	*	

BATHYMETRICAL DISTRIBUTION TABLE.

	Littoral.	FATHOMS. 4	8	10	18	20	40	45	50	120	350	435	450
Lacuna ampullæformis	*		*		*	*	*	*	*	*	*	*	*
,, globosa	*		*		*	*							*
,, fistulosa	*					*							
,, radiata	*					*	*						
,, radicans	*												
,, pubescens								*					
,, sporangifera	*		*	*	*	*	*	*		*			
,, incerta								*					
,, moniliformis						*							
Achyla perforans	*				*	*	*	*	*	*	*	*	*
,, nodosa						*		*			*	*	
,, porosa	*			*			*						
,, cervicornis	*		*	*	*								
,, simplex	*		*					*					
,, villosa	*					*		*					*
,, gracilis	*					*	*						*
,, flexuosa	*				*								
,, radiata					*	*		*					
,, tortuosa	*					*		*					
,, articulata	*		*		*								
,, minutula	*	*	*	*				*		*			
,, fasciculata	*	*	*	*	*	*							
,, quadradiata	*												
,, ditto, var. villosa	*								*				
,, flabelliformis	*		*	*				*					
,, reticulata								*					
,, aculeata				*									
Saprolegnia	*				*	*	*	*		*	*	*	*
Varneia villosa	*					*		*					

Probably the majority of forms known as *Lacunæ* are merely a phase or condition in the life history of the plants, or possibly the initial stage of a filamentous species. Plate 9, Fig. 2 × 210.

Lacuna radiata.—The flask-like cavity of this species is rather deeply immersed in the containing fragment: the neck-like portion is considerably elongated and very small in diameter.

The exterior surface of the globular portion is distinctly mammillated, and from each apex, branched or unbranched, very fine hair-like processes are produced, which reach the surface.

They usually occur separately, but I have seen indications of two becoming confluent; spore-like bodies having an amber tint are present in some instances; these escape through an eroded aperture, which destroys the neck-like portion of the organism.

Widely distributed, but not very common. British material has furnished the best examples—notably Kenfig Pool, Bristol Channel.

Found in shallow-water deposits. Plate 9, Fig. 3 × 210.

Lacuna radicans.—This species is very variable in form, and may consist of a simple or unbranched central cavity, or they may assume various contours according to the number of branches they produce.

The central cavity, however, is tolerably large, and gives off at frequent intervals, around the margin, very fine and freely branched filaments, usually decreasing in size towards their extremities.

Always solitary.

Not common. Occurs in material from Morte Bay, and in another gathering, the precise locality of which I have been unable to ascertain. Plate 9, Fig. 4 × 150.

Lacuna incerta.—This organism appears to be allied to *L. sporangifera*, but there are distinctive features which render its identification comparatively easy.

It always occupies a superficial position in the shell; the central cavity is large, exceedingly irregular in form, and the surface is thickly perforated, giving it a sieve-like appearance.

In some specimens numerous processes are given off from the margins; these are slightly expanded towards the base, and terminate in hair-like filaments, or the expanded portion may be absent, the fine filaments alone being present.

They multiply by forming young plants near the ends of the fine filaments when these reach the surface.

Rare. In material from Java Sea and Macassar Straits, 45 fathoms.

Lacuna moniliformis.—This organism consists of a series of irregular-shaped *Lacunæ* connected by filaments, which, when fully developed, are freely branched and liberally provided with short excretory ducts.

This is one of a few plants met with which appear to occupy an intermediate position between the genera *Lacunæ* and *Achlyæ*; the characteristic features of both are so intimately combined and balanced that valid objections could be raised against a preference being created for either as

the generic term ; and probably, when more is known regarding the entire group, a separate genus may be created for such forms.

Very rare. *Challenger* Station No. 23, off Sombrero Island, West Indies, 450 fathoms. Plate 9, Fig. 5 × 300.

Genus Achlya.

Achlya fasciculata.—This is a rather minute organism ; typical examples are generally deeply immersed within the shell ; the branches radiate from a central point in every direction, they divide dichotomously at frequent intervals, and when fully developed form compact little spherical bundles.

Sometimes the plants occur near the surface of the containing fragment ; they are then outspread, forming circular patches ; the filaments are much crowded, but they do not become confluent.

No appendages are visible.

Widely distributed. Not uncommon in dredgings from foreign localities ; rather rare in material from the British coasts.

Achlya monile.—A small and very interesting organism ; it is highly branched ; the filaments in their early stage of growth have a distinctly septate appearance (probably illusory), but as they mature this feature becomes more prominent by the enlargement into bead-like cavities, which are sometimes contiguous, at others slightly separated.

The filaments are rather large in diameter for the size of the plant, and they have a tendency to erode the surface of the shell. Devoid of appendages.

Very rare. Typical specimens have been found in recent material from Lagos Bay, S. Australia, and in Miocene deposit from Auckland, New Zealand. Plate 9, Fig. 6 × 300.

Achlya radiata.—An easily recognised species. The filaments arise from a small circular cavity; at first they are few in number; they divide dichotomously but sparingly, and taper gradually towards their extremities; they are of considerable length.

The plants occupy a superficial position in the containing fragments, and they appear to be devoid of special means for contact with the water.

Very rare. Fine specimens were obtained from Java Sea, 45 fathoms, doubtful examples from the Cornish and Welsh coasts, and very small plants in Miocene material from France.

Achlya tortuosa.—This is a very complicated form ; to convey a correct idea, by words alone, is rather difficult.

In some instances there are indications that the organism consists of filaments of two distinct forms, but whether this is a permanent feature or not, I am at present unable to state.

The most striking characteristic is the manner the filaments wander in every conceivable direction in a zigzag way, and at the same time forming graceful curves, completely covering the surface of the shell and yet not becoming confluent ; sometimes these branches may be seen to arise from

others which are almost straight and apparently more deeply immersed within the shell containing the organism, but further investigation is necessary.

The filaments appear to be devoid of appendages.

Widely distributed, but not very common; not observed below 45 fathoms.

Achlya minutula.—Exceedingly minute plants, usually about one-fiftieth of an inch in diameter when mature, occurring generally in groups much crowded together.

The plant branches freely, and the filaments have an undulating appearance, the true cause of which I have been unable to determine; no appendages are visible by any power I have been able to use.

Widely distributed. Rare within the British area.

Not observed below 120 fathoms.

Achlya gracilis.—The distinguishing characters of this species appear to be more uniformly persistent than in many of the members of the group.

The filaments may be divided into three distinct groups, which always occupy separate portions of the shell they invade.

The contour of the plant is displayed at or near the surface of the nacreous layers; at frequent intervals branches are given off which descend vertically into the shell; in some instances these terminate in irregular-shaped cavities (to which further reference will be made), while others pass on until they sometimes reach the opposite surface, where they may terminate, or they may be deflected and return for some distance towards the original point of entry.

These filaments may be simple and hair-like, or they may be slightly branched.

The superficial aspect of the plant conveys the idea of rigidity, caused by the uniformity with which the branches divide.

The filaments are exceedingly small in diameter, and at the point where they descend into the shell they appear to be jointed, but I am not satisfied on this point.

The vesicles which terminate the short branches are generally contained wholly within the nacreous portion of the shell; in their perfect condition they are spherical, and are provided with an excretory duct, but they appear to speedily erode the shell and form irregular-shaped cavities; with the exception of the excretory duct referred to, the plant appears to be destitute of appendages for communicating with the surrounding water; in this respect it appears to occupy an intermediate position between the group so provided and that which is quite destitute.

Widely distributed, but rare outside the British area. Plate 9, Fig. 7 × 300. The figure exaggerates the diameter of the filaments.

Achlya fluxuosa.—This organism possesses nearly all the features of *A. gracilis*, but instead of having the rigid appearance of the latter, the superficial branches are beautifully curved; the individual plants are smaller and nearly circular in contour; it appears to quickly erode the surface of the shell, leaving continuous channels which present a serrated appearance at the margins.

The cavities which terminate the shorter branches are irregular in form; some are nearly globular, others cylindrical, and occasionally they assume the form of little groups of filaments built up like a string of beads, like the reproductive bodies of *Penicillum glaucum*; but whatever their form, they occasionally appear to be thickly beset with short hair-like appendages.

The two species are apparently closely related. I can recommend the study of this organism to intending workers, as the subject is by no means exhausted.

It has not been observed in any material from outside the British area. Comparatively common in littoral deposits of the Cornish and Devonshire coasts. Plate 9, Fig. 8 × 180.

Achlya articulata.—A very well defined species, but rather difficult to detect owing to the plants being rather small and usually rather deeply immersed in the substance of the shell they invade.

The filaments are composed of numerous elongated pear- or club-shaped joints, articulated in a regular system, the bulbous parts being the growing ends.

The joints more deeply situate appear to be destitute of appendages, but as they approach the surface rather long simple tubular processes are developed.

The plants branch rather freely and in moderately thick shells; several whorls may be observed, causing the organism to assume the form of a bush in miniature.

Very rare. Found in material from *Challenger* stations 172 and 187, and in littoral material from Whitesand Bay, Cornwall. Plate 9, Fig. 9 × 300.

Achlya simplex.—This is a very well defined and easily recognised species. Robust in habit.

Mr. Waller has given an excellent illustration of the peculiar manner of the development of the filaments in Plate XV., fig. 9, which accompanies his paper, but the specimen from which the drawing was made was evidently immature, as in its perfect condition it appears to be a freely branching species.

The filaments consist of a series of segments of a circle connected in regular succession; they arise from the convex side, at a point about one-fifth the length of the segment, the free end of which reaches the surface of the shell and perforates it, causing a succession of circular apertures corresponding to the size of the filaments.

Widely distributed, but not common. Appears to be associated with moderate depths.

Achlya porosa.—This is a very minute species, evidently closely allied to the preceding.

The filaments are produced in a precisely similar manner, but the branches are generally less regular in their arrangement, and include a wider range of angles than is observed in *A. simplex.*

Widely distributed; not common. Associated with *A. simplex* in some gatherings. Not observed at a greater depth than 45 fathoms.

Achlya cervicornis.—A very minute and exceedingly graceful species; very sparingly branched.

The filaments are furnished with appendages at regular intervals; these do not maintain the size at the apex they assume at the base, but taper to quite fine points, in this respect differing from *A. simplex* and *A. porosa.*]

Very rare. The only specimens obtained were found in material from *Challenger* Stations 172 and 187, and from Java Sea, Lagos Bay, and King George's Sound, Australia, also from Barbadoes.

May be regarded as a shallow-water form.

Achlya nodosa.—This species appears to be closely allied to *A. perforans*, the distinguishing feature being the frequent and nearly uniform expansion of the filaments into nodular areas, whence arise lateral branches; these are developed at all angles, and retain the same feature.

The appendages or excretory ducts are fairly numerous; they consist of short, rather stout, tubular processes arising from the median line of the filaments.

Not common, although widely distributed. Found at all depths down to 435 fathoms. Plate 10, Fig. 10 × 300.

Achlya villosa, var. *quadradiata.*—The filaments of this variety are generally rather robust, and are thickly clad with fine hair-like appendages; they branch rather sparingly, the branches being produced at right angles, sometimes singly, at others in pairs, in opposite directions; they then form a quadradiate figure.

Achlya villosa is a very variable plant, even when selected from dredgings procured from one locality: thus the filaments may be small or very robust; sometimes they exhibit nodular expansions at irregular intervals; or again, they may be thickly clad with long appendages, or so sparingly furnished and so short as almost to escape detection.

Such variations naturally raise a doubt as to any useful purpose being served by referring to the variety, and I should not have done so but for the precedent set me by Mr. Waller in his paper on the Gabbard sands. I am disposed to regard the feature more as an accident of growth than of specific value.

Achlya aculeata.—This is a very elegant and minute species, occurring singly in shells, covering the surface with numerous very minute patches.

The filaments have the appearance of being built up of innumerable short club-shaped joints, each in turn giving rise to one or two similar growths; the plants thus become a perfect network of short branches, which, however, do not become confluent; this part of the plant is rather deeply embedded in the fragment, and each joint is very liberally furnished with appendages; these are sometimes simple, but frequently they are branched, occasionally becoming divided into five or six terminal processes, which reach the surface of the shell and give the organism a very bristly appearance.

The plants arise from flask-shaped cavities, which in their initial stage are also provided with similar appendages.

Very rare. Appears to be a coral-reef species, found in material from Barbadoes, shallow water.

Achlya reticulata.—This is a very distinct, robust, and exceedingly handsome species.

It occurs in fragments of shell and foraminifera of the genus *Operculina*; when suitably placed for free development it usually forms a circular patch, frequently attaining the one-twentieth of an inch in diameter.

The filaments are fairly large, but they are irregular in size; branches are produced at frequent intervals, which soon coalesce and form a perfect network of filaments arranged in graceful curves; the surface is very liberally furnished with short, rather stout appendages (excretory ducts), the apertures of which vary in form and size, giving the organism the appearance of being decorated with minute gems.

Rather plentiful in material from Java Sea and Macassar Straits, 45 fathoms; but not found in any dredgings outside this area. Plate 10, Fig. 11 × 180.

Achlya flabelliformis.—This is a rather small organism, but its distinguishing features are very well defined. It may be described as consisting of two distinct parts—viz., a tubular portion, which gradually passes into an expanded part.

The tubular portion frequently perforates the enclosing fragment, entering on one side and passing in an oblique direction to the other surface; occasionally it may reappear on the same side it entered, forming in its course the segment of a circle; but however it behaves in this respect, it always expands as it reaches the surface, and ultimately assumes a fan-like form with a few growing points slightly in advance of the main body.

The surface of the expanded portion is plentifully furnished with rather short, stout appendages; the tubular part is also provided with similar organs for some distance from the expanded part, but more sparingly, the portion near the original point of entry being destitute.

Very frequently the surface is eroded to some extent, thus exposing the interior of the organism.

Rather rare. Appears to be a comparatively shallow-water form; coral-reef material has furnished the majority of the specimens. Plate 10, Fig. 12 × 300.

The following species have been dealt with by Mr. Waller:—

Lacuna ampullaeformis.
,, *sporangifera.*
Achlya perforans.
,, *villosa.*
Saprolegnia varniensis.
Varneia villosa.

On the Structure of the Nodules in Pleurosigmæ.

(*Climacosphenia moniligera.*)

By Edward M. Nelson, P.R.M.S.

(*Read December* 16*th*, 1898.)

Plate 10.

While examining the *Pleurosigmæ* in the Nottingham (Maryland, U.S.A.) deposit I was much struck with a marked difference in the structure of the nodules when compared with those of recent forms. Now, as the Nottingham deposit belongs to the Middle Tertiary Period, it cannot fail to be interesting to compare these with other fossil and recent forms.

Fig. 1 shows the raphæ pipes entering the nodule of a Nottingham *Pleurosigma*, as seen from the outside of the valve. You will notice that both ends of the pipe, after making a slight dip, terminate with their extremities pointing directly at one another. Fig. 2 is a very highly magnified picture of the extremities of the pipes; they are joined by a very fine thread-like structure, which by the way is an excessively difficult image. Passing on now to the nodule itself, we come in fig. 3 to an inside view at the highest focus; fig. 4 is the same at an intermediate focus; focussing down still lower we come to an inside view of fig. 1, which being similar to it renders another figure unnecessary.

Turning now to a *P. angulatum*, we have in the outside view at fig. 5 the extremities of the pipes very differently arranged. Here we see the left-hand pipe slightly bent down, while the right-hand one is considerably turned to one side. Passing on to an inside view, fig. 6, we also find a totally different structure: the nodule has become oval, with the raphæ pipes running a little way into it at each extremity. Focussing down, we come to the inside view of fig. 5, there being no intermediate image, as was the case in the fossil form.

In fig. 10 the ends of the raphæ pipes of a Nottingham *pleurosigma* are shown greatly magnified, and it will be seen that

one side exhibits a tendency to turn down, this slight displacement being just perceptible. Care must be exercised always to examine a specimen that is lying flat, for if it is tilted fallaceous appearances will be present; also it is better to examine these structures from the outside, because an inside view usually presents more difficulty.

It may be said that this is only a matter of slight variation, such as is to be met with in all the diatomaceæ; but twenty-four varieties of *Pleurosigmæ* have been examined, and not a single instance of the ends of the pipes pointing to one another has been observed. The following is a list of the twenty-four varieties of *Pleurosigmæ*:—

P. formosum, decorum, elongatum, strigosum, rhombeum, convexum, quadratum, angulatum (3 varieties), *æstuarii, naviculaceum, balticum* (3 varieties), *strigilis, attenuatum, hippocampus* (2 varieties), *acuminatum, scalproides, affine, eximum, affine* var. *fossilis*, Richmond, U.S.A.

In addition to these *P. fasciola* and *littorale* were examined, but the structure in both these forms is so minute that it could not be traced. *P. spectabile* has such a deep nodule that the structure on the upper surface could not be seen by an inspection from the inside; a valve mounted the other way up was not at hand.

The ends of the pipes in *P. formosum* are shown in fig. 8; they are not very easy to make out, for although it is a very large *pleurosigma* it has nevertheless a rather small nodule. *P. decorum* is merely a replica of *P. formosum*. *P. rigidum* is a very difficult one to observe: it has one end of its raphæ pipe straight, the other comes straight towards it, and then turns very slightly to one side.

In exterior shape the Maryland *Pleurosigma* and *P. affine* var. *fossilis* Richmond are very similar to the *P. angulatum*, met with in common spread slides, but in *P. affine* the extremities of the valve are blunter and more like *P. rigidum*.

With regard to the sigmoid curve of the raphæ, that of *P. rigidum* is the straightest, *P. affine* is straighter in the centre and curves more rapidly at the extremities, while in *P. affine* var. *fossilis*, the Maryland *pleurosigma* and *P. angulatum*, the curve of the raphæ has a more regular sweep throughout. In fact, these three diatoms—viz. *P. affine* var. *fossilis*, the Maryland *pleurosigma*

and *P. angulatum* may be considered identically the same as to their exterior shape, the only differences between them being in the nodules and in the coarseness of their perforated structures. *P. affine* differs from these three in the bluntness of the extremities of the valve, in the sweep of the curve of its raphæ, in the excessive coarseness of its perforated structure, and in the oval shape of the perforations. The termination of its raphæ pipes follows *P. angulatum*, but the shape of the nodule is like *P. affine* var. *fossilis* and the Maryland *pleurosigma*. As diatoms are named neither from the termination of their raphæ pipes, nor from the shape of their nodules, but solely from their exterior form, it is difficult to understand why the *P. affine* var. *fossilis* should have been named a variety of *P. affine* and not of *P. angulatum*.

With regard to the perforated quincunx pattern all over the valve, that on the Maryland *Pleurosigma* is coarser than that on *P. angulatum*, but in other respects it is very similar. That of *P. affine* is coarser than that on any other *Pleurosigma* I am acquainted with, and curiously the perforations are, as just stated, oval. That on *P. affine* var. *fossilis*, however, is finer and less oval than that on *P. affine*. The structure on the *P. affine* is so coarse that it can be easily resolved by any lens of ·45 N.A. aperture, with axial cone illumination, but the same lens will barely show striæ on a *P. angulatum* with oblique light. An apochromatic 4 mm. for the long tube will show the bent raphæ pipes in *P. affine* (balsam), *P. affine* var. *fossilis* (balsam), and in *P. angulatum* (dense medium), but it will show neither those in *P. angulatum* (dry mount), nor in the *N. firma* var. *Hitschcockii* (balsam), to be mentioned presently, although this last is a striking object with an oil immersion $\frac{1}{8}$. With regard to the different forms of nodules they may be divided into four groups. 1st, the Maryland form (figs. 3 and 4). 2ndly, the *angulatum* form (fig. 6). 3rdly, the *Balticum* form, which outwardly resembles the *angulatum* form, but its raphæ pipes enter farther into the nodule, and they have distinct knobs * where they turn down into the thickness of the silex, also the perforated structure is displaced to the right and left of the nodule. 4th and lastly, we find a nodule intermediate between the *angulatum* and *Balticum* forms.

In the first group we have the Maryland *Pleurosigma*, *affine*, *affine* var. *fossilis*, *rigidum*, *rhombeum*, *convexum*, *naviculaceum*.

* The Cherryfield *Rhomboides* has somewhat similar knobs.

In the second *P. angulatum, formosum, decorum, elongatum, strigosum, quadratum, æstuarii, acuminatum, littorale, fasciola.*

In the third various varieties of *P. Balticum.*

In the fourth *P. attenuatum, strigilis, hippocampus, eximum, scalproides.*

In *hippocampus* the ends of the raphæ pipes are equally turned aside, and being strong are very easy to observe; there are also small knobs like *Balticum.*

Among the *Naviculaceæ* there are in Moller's Type Plate six varieties of *N. firma*, which have the extremities of their raphæ pipes turning in opposite directions. That of *N. firma* var. *latissima*, now known as *Nav. tumescens*, was admirably figured by Mr. Karop (*Journ. Q. M. C.*, Pl. II., Figs. 19 and 20, Vol. 4 ser. 2, 1891), and described by me on page 318. (The diatom there is called a *Pinnularia*, but I have since been informed that it is *N. tumescens*). The pipes come down the raphæ to the nodule, and then they spirally descend, with a right and left hand twist respectively, through the thickness of the silex into a chamber, which opens into the inside of the valve by the aperture, seen in fig. 19 (*tom. cit.*). The smallest of the six forms of *N. firma* examined is named var. *Hitschcockii*, and it has the most diverging pipe ends of all: so much is this the case that, instead of finding their way into the central nodule, they pass outside it into a primary areolation on either side of the nodule (fig. 9). Now this diatom, as well as the *N. tumescens*, are fossils, so it would appear that these *Naviculaceæ* had put on this peculiar adaptation, while the Nottingham *Pleurosigmæ* were only thinking about it.

These observed facts naturally give rise to the following questions. It is obvious that the Maryland *Pleurosigma* is a very old form, so also is the *P. affine* var. *fossilis*; as these have straight or nearly straight raphæ pipes, and also nodules of the first group, may not these structures be taken as indications of early types? If this is the case, may we not conclude that the varieties of *Pleurosigmæ* named in the first group are survivals of this old type, and may not those mentioned in the second group be later forms? Thus, for example, may we not consider *P. rigidum* as the most perfect survival of the oldest type of *Pleurosigma* yet known, because it has the same form of nodule and straighter raphæ pipes than any of the more recent forms?

Climacosphenia Moniligera.

There is another diatomic structure, quite unconnected with the scope of this paper, but which nevertheless I would like to bring to the notice of the Club, as it is one of the most beautiful and interesting, as well as instructive, of microscopic structures. This is a diatom known as a *Climacosphenia moniligera.* The principal view of the valve shows an elongated isosceles triangle, having three bands running its whole length. The outer bands are sieve-like structures; the minute holes being closer together in the transverse than in the longitudinal direction.

In common parlance it would be said that the longitudinal striæ were finer than the transverse; the transverse striæ vary, however, being finer at the wide end of the valve, where they count 53,000 per inch, and coarser at the small end. This agrees with the law of diatom formation in circular forms I have on several occasions pointed out—viz., "immature at the centre, mature at the periphery"; the growth of circular forms being from the centre outwards. The *climacosphenia* grows from the base or small end towards the apex or wide end.

The middle band has coarse structure at the rate of 33,500 per inch. It takes a fine 12 mm. apochromatic to dot the outer and finer bands near the apex or large end in a balsam mount, with axial cone illumination. When this diatom is seen sideways it shows the interesting structure alluded to above; this consists of a helical pipe passing through some bulkheads, which divide the diatom into several compartments. As we come to the compartments near the wide end, or older part of the valve, we find that the pipe closes up and the bulkheads become solid silex.

Mr. Rousselet has appropriately suggested that this structure is a useful test for 12 mm. apochromatics, and similar objectives. With such glasses, however, the helical tube appears only like interlocking teeth, it requires more aperture to develop its full beauty. In conclusion, let me say that this is an object that will repay careful examination.

I must express my indebtedness to Mr. Morland, not only for the loan of slides from his unrivalled collection, but also for his kind assistance in the preparation of this paper; and also to Mr. E. T. Newton for geological information.

A Method of making Type Slides for Opaque Objects with Removable Cover.

By D. Bryce Scott.

(*Read by* A. Earland, *January 20th*, 1899.)

The first step is to prepare the photographed bottom on which the objects are fixed. This can, of course, be prepared to any size or pattern, according to the requirements of the mounter. For my own purposes I prepare a slide having its surface divided into 300 spaces of varying sizes, which is constructed thus :—

1. Take a piece of black cardboard $32\frac{1}{4}$ inches long and $11\frac{1}{4}$ inches wide. Scale off $20\frac{5}{8}$ inches into 25 divisions lengthways, then scale off $6\frac{1}{4}$ inches downwards into 12 divisions, making the first division downwards the same breadth as the 25 divisions along the top, which will thus become squares. Gradually reduce the size of the remaining divisions downwards, until those in the last line are only $\frac{1}{3}$ the breadth of those in the top line. Then number the spaces in the corner from 1 to 300. All the lines and figures are to be made with china white, dissolved in water, with sufficient gum added to make the white adhere when dry.

Photograph down to $\frac{5}{8}$ of an inch wide and $2\frac{1}{16}$ inches long. The printed photos are next pasted upon ordinary portrait photo cards, and burnished. They are then varnished by pouring a thin filtered solution of shellac over them, and allowing it to dry. Unless this is done the slightest scratch will show on the photograph, which is very delicate, and will not stand much rough usage. The shellac preparation used by photographers to pour over tin types will be found best for the purpose, as it dries very quickly.

Cut the cards on which the photos are mounted to the standard

size, 3 inches by 1 inch, taking great care to ensure that the background is exactly centred on the card.

2. Take a slip of dry and well-seasoned bay wood or mahogany, 3 inches long, 1 inch wide, and $\frac{1}{16}$ inch thick (thinner or thicker if required). Glue over the strip on each side a piece of manilla paper of good quality, using liquid glue, and dry under a flat weight.

When dry cut out the centre of the wooden slip, leaving a strip $\frac{1}{8}$ inch wide on each side, and $\frac{5}{16}$ at each end. Smooth down all roughnesses with fine glass-paper, and blacken all over with lamp-black in alcohol. Add sufficient shellac to the alcohol to make the lamp-black adhere to the cell, but not enough to make a gloss.

3. Glue the photographed bottom to the wooden cell with liquid glue, and dry under a flat weight.

4. Place a thin glass slip, 3 inches by 1, of best quality, with ground edges, on top of the cell.

5. Take a slip of good manilla paper, about 3 inches long by $2\frac{1}{4}$ inches wide, moisten with a sponge, wrap it round the cell and glass slip, and glue the edges on the back of the photographed bottom. Be very careful that no glue touches the glass cover. All the manilla paper used in the preparation of the slide must be damped but not soaked; the damp paper stretches and works better.

6. Take a strip of manilla paper, 1 inch by about $6\frac{1}{4}$ inches long, damp and glue it, and paste over the last strip. This strip will go right round the long diameter of the slide. No glue must be allowed to touch the glass cover where the paper goes over it at the ends.

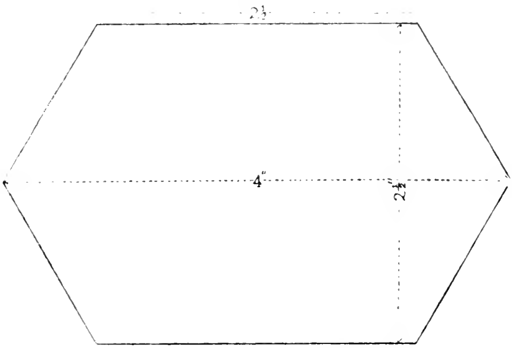
7. Cut a piece of manilla paper to the size and shape of sketch No. 1. Damp and glue it, and wrap round the slide, folding the corners over neatly.

None of the edges of these three thick papers (paragraphs 5, 6, 7) must overlap, or the surfaces of the slide will be uneven when finished. Trim the papers to the exact size when the liquid glue is on the paper.

8. Glue on a strip of thin black paper (black tissue) cut to the size and shape of sketch No. 1. Thin the glue with a little water, just thin enough to prevent the paper tearing when it is brushed on.

9. Glue on a similar piece of black paper, cut as in sketch No. 1, making the join on the opposite side of the built-up cell.

10. Cut a piece of thin black paper, 3 inches by 1, and glue over the last-made join. Press the finished slide between two flat surfaces, such as a table and a piece of smooth hard wood, to squeeze out all the air cells in the moist paper. Put it away to dry for two or three days.

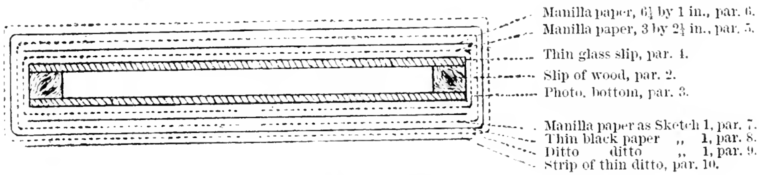


No. 1. Shape of Paper, as paragraphs 7, 8, 9.

11. When the cell is dry, cut out the centre of the surface on the side having the glass cover (see paragraph 12), $2\frac{3}{16}$ inches long by $\frac{3}{4}$ inch wide, leaving about $\frac{1}{8}$ inch on each side and $\frac{5}{16}$ inch on each end. Then cut off one end $\frac{1}{16}$ of an inch on top and $\frac{1}{16}$ inch on the end of the cell. This will allow the glass cover to be pushed out through the slot thus made at one end of the slide. If there is no glue on the glass it will come out quite easily when you press it with your thumb and slide it towards the slot; or it can be pushed out from the opposite end with a blunt needle pierced through the paper. Do not use a sharp needle, or you will crack the slide. Before cutting the slot in the end of the slide measure both ends accurately and cut the widest end, as the glass slips are frequently a little wider at one end than at the

other. Grind the corners of the end to be pushed in on an oil-stone: this will prevent the usually sharp corners of the glass from tearing the paper when it is pushed into place.

12. When building up the slide keep sketch No. 2 in front of you and work in the same way. By this means you will always know which is the top or glass cover side, as the bottom is the side on which the last strip, 1 by 3, is pasted (paragraph 10).



DIAGRAMMATIC.

No. 2. Transverse section through centre of slide.

13. Take the glass slip out, and replace it with a strip of mica or thin tin. Blacken the edges where cut, and put aside for an hour for the black to dry. Then replace the glass slip, and put aside in a warm place (not hot) for five or six days, to thoroughly dry and season. If allowed to dry without the glass slip being in place, it will be sure to warp.

The Winter Egg of a rare Water-Flea (*Leydigia acanthocercoides* Fischer).

By D. J. Scourfield.

(*Read January 20th, 1899.*)

Plate 11.

There seems no room for doubt at the present day that the production of winter or resting eggs is of universal occurrence among the little animals belonging to the Crustacean sub-order Cladocera, notwithstanding the fact that in many species such eggs have not yet been observed. In the most representative family, the Daphnidæ, these special eggs are always enclosed in a very remarkable and complex modification of the shell of the mother, commonly known as the "ephippium," because of its resemblance to a saddle both as regards shape and position. In the other Cladoceran families the production of an ephippium, similar in all respects to that found among the Daphnidæ, is extremely rare, the only certain instance, so far as I know, being *Macrothrix spinosa* King, recorded by Professor G. O. Sars in "Additional Notes on Australian Cladocera raised from dried mud" (7). Nevertheless structures clearly homologous to true ephippia, though usually very much simpler, are found in the families Bosminidæ, Lyncodaphnidæ, and Lynceidæ. The species belonging to the remaining families of the Cladocera appear to allow their resting eggs to escape freely into the water without providing them with any auxiliary coverings.

The earliest mention of resting eggs among the Lynceidæ, to which family the species dealt with in this paper belongs, is to be found in Jurine's "Histoire des Monocles" (2), published in 1820. In speaking of the smaller forms of the Cladocera which exhibit a very evident eye-spot (*i.e.* mainly the Lynceidæ), he says (p. 148), "La selle qui couvre leur dos ne contient jamais qu'une seule boule, laquelle est placée au milieu de cette pellicule noire et y fait saillie." He also distinctly refers to the saddle or ephippium

in the case of *Chydorus sphæricus*, and gives a small drawing of it on Plate XVI. (fig. 3 h). Schödler was the next, perhaps, to observe resting eggs among the Lynceidæ, for in 1846 he recorded (9, p. 372) that he had observed in *Eurycercus lamellatus* that a number of winter eggs were deposited at one time in the almost unmodified cast shell of the mother, a fact which has since been confirmed by Weismann (13). In a subsequent paper (10) Schödler referred again to the same subject, and also briefly alluded to the winter eggs of *Chydorus sphæricus* and *Peracantha truncata*. The earliest considerable contribution, however, to our knowledge of the winter eggs of the Lynceidæ, and their comparatively simple protective coverings, which I have termed elsewhere (11) "proto-ephippia," we owe to the patient observations of Kurz, who in 1874, in his paper "Dodekas neuer Cladoceren" (3), recorded their existence in some sixteen species belonging to the genera *Camptocercus*, *Alona*, *Pleuroxus*, *Chydorus*, etc. Slightly later, 1877, Weismann independently discovered the resting eggs of several species of the same family,* some of which he briefly described and figured in the second "Abhandlung" of his "Beiträge zur Naturgeschichte der Daphnoiden" (13). Since that time, of course, the resting eggs of many other species have been alluded to, in more or less detail, by various writers. None of the proto-ephippia which have been described, however, show any very close approach to the true ephippia of the Daphnidæ. The most modified proto-ephippium hitherto recorded is probably that of *Chydorus sphæricus*. But it will be readily admitted that, although this structure exhibits many of the features of a genuine ephippium in a more or less rudimentary condition [see Kurz (3), p. 77, and Scourfield (11), p. 64], it is yet a long way behind its highly evolved Daphnidan homologue. As, therefore, I have recently found that the winter egg of *Leydigia acanthocercoides* Fischer is provided with a proto-ephippium which exhibits a considerable advance upon that of *Chydorus sphæricus*, and at the same time possesses some other interesting features, I have thought it worth while to bring forward my observations in a special communication.

* Both Kurz and Weismann seem to have thought that they were the first to discover the winter eggs of Lynceidæ, but as has been already mentioned at least two previous authors had referred to these productions.

The first specimen of *Leydigia acanthocercoides* seen by me was in the condition shown in Fig. 1 (Pl. 11). It was found in October last, in sediment collected from the bottom of Barton Broad, Norfolk, at the end of September. The animal, which was dead when found, had apparently attempted to moult, but had only been partially successful. It was evident at once, by the dark colour of the dorsal part of the shell, that a proto-ephippium, having an outline strikingly similar to that of the ephippia of some species of Daphnidæ, had been produced; and I further noticed, but without at first realising its significance, that the entire free margins of the valves were darkened almost to the same extent as the proto-ephippium.

Closer inspection soon revealed several other curious facts. For instance, it was noticed that the ventral margin of the darkened dorsal area constituting the proto-ephippium was marked by a line of approximately rectangular cells which were only loosely attached in their places. A highly magnified view of the anterior part of this line is shown in Fig. 2. On the left is a corner of the proto-ephippium, the anterior margin of which is formed, as is usually, if not always the case, by the line of junction between the head-shield and the valve. On the right, above, is a portion of the darkened and possibly thickened free anterior margin of the valve; while below this the unmodified part of the valve is indicated by the fine striæ on its surface. Some of the anterior cells of the boundary line have already fallen out; others are quite loose, as is shown by their positions. These cells seemed to be quite free from markings of any sort, although the surface of the head and valves in this species is covered with extremely minute and closely-set striæ, just as in *Alona affinis*. The special function of this line of loosely connected cells is evidently to allow of the easy separation of the proto-ephippium from the unmodified part of the valves.

The next peculiarity observed was that the line of cells above referred to was not limited to bounding the ventral margin of the proto-ephippium, but was continued completely round the free edges of the valves just within the darkened margins. This gave the clue at once to the meaning of the modified valve margins. If the shell had been completely moulted they would no doubt have broken away from the unmodified parts of the valves, and, remaining attached to the proto-ephippium, would

have become converted into two enormous hooks. With a few touches of a small brush I was able, with a second specimen which was secured directly after being thrown off, to remove all the unmodified parts of the carapace, etc., and then the proto-ephippium appeared as shown in Figs. 3 and 4, which give lateral and ventral views respectively of this very peculiar structure. Later in the year, November 5th, I was fortunate enough to find at Richmond Park another specimen of this proto-ephippium exactly in this condition.

So far as I know, this structure exhibits the most highly developed adaptation for dispersal * that has yet been seen among the resting eggs of the Cladocera. As a rule ephippia and proto-ephippia are not provided with hooks, spines, or any such contrivances for dispersal. The principal exception to this is that the ephippia of Daphnias belonging to the *D. magna* group are usually furnished with anterior and posterior extensions of the dorsal margin which are closely set with little recurved teeth. A good example of this is shown by Sars in the figure of the ephippium of *Daphnia lumholtzi* in his paper "On some Australian Cladocera raised from dried mud" (6). In *D. magna* itself, moreover, more or less considerable portions of the free margins of the valves may also remain attached to the ephippium, as was shown by F. A. Smitt in his paper "Sur les Ephippies des Daphnies" (12). In fact, his figure of the ephippium of *D. magna* (Pl. IV. Fig. 1) shows a quite remarkable similarity in this respect to what has just been described in the case of *L. acanthocercoides*. But the attachment of the shell margins to the ephippium of *D. magna*, at least to the extent figured by Smitt, does not seem to be usual. So far as I know, Smitt is the only author who has mentioned such an arrangement, although the ephippia of this species have been referred to again and again. I have myself examined a fair number of these ephippia, but only rarely have I seen portions of the shell margins still attached to them, and I have never in any case found more than about half the posterior margin so attached. Further, neither before nor after the

* I believe that dispersal and not anchoring is the object served by such adaptations, because of the impossibility of conceiving how the anchoring of resting eggs could be of benefit to animals like the Cladocera, which live almost wholly in still waters, while on the other hand the advantages of dispersal are apparent.

moulting of the ephippium have I ever been able to see any special modification of valve margins. I am inclined to think, therefore, that the retention of the valve margins in this case is more or less a matter of accident, although it is evidently a step in the direction of the very perfect modification exhibited by *Leydigia acanthocercoides*.

As regards the structure of the main portion of the proto-ephippium of *L. acanthocercoides* the following facts were noticed. The usual chitinous thickening along the dorsal edge was very well developed; not so much comparatively as in *Chydorus sphæricus*, but much more than in the majority of the Lynceidæ. The outer shell still retained its primitive striation, though the lines seemed more confused, as if they had been thickened by irregular deposits of chitin. The most peculiar feature about the structure of the proto-ephippium, however, was that the whole of the space between the outer case and the egg was filled with a mass of tissue consisting of irregularly polyhedral cells (see Fig. 5). This was so thick that, combined with the abundant deposit of pigment in the outer case, the resting egg itself could only be seen in a very ill-defined way. I may remark here that I have noticed the existence of somewhat similar cellular tissue in the proto-ephippium of *Alona tenuicaudis*. It is, no doubt, an extreme development of the delicate inner membrane which I have found to surround the egg in nearly all proto-ephippia, and is homologous to the definitely formed inner capsule of such typical ephippia as those of *Daphnia magna* and its nearest allies. Its chief function is obviously to form a soft spongy "packing" around the egg, and so to more effectually preserve the latter from injury. When the proto-ephippium of *L. acanthocercoides* was viewed from the front (see Fig. 4), the two valves were seen not to quite meet along the middle line, but the space between them was effectually closed by the inner cellular tissue. Towards the posterior end, this "packing" was so plentiful that it protruded from the shell as shown in Fig. 3, and it was here that its structure could be best made out. The limits of the cellular tissue within the outer case were fairly definite, and are shown in the figure just referred to by the line bounding the darker portion of the proto-ephippium.

From the foregoing description of the proto-ephippium of *L. acanthocercoides* it will be seen that in no less than three respects it is considerably in advance of that of *Chydorus sphæricus*,

which, as already stated, is perhaps the most highly evolved of the proto-ephippia hitherto recorded. First, it is formed, as in the Daphnidæ, from a much more limited portion of the shell, bounded approximately by a semicircle described upon the dorsal margin; secondly, it possesses a thick inner coat of specially formed spongy tissue; and thirdly, it is provided with large hook-like appendages. In spite of these advances in complexity, however, it does not quite reach the level of the Daphnidan ephippium, because its outer coat is not specially altered beyond the mere deposit of pigment and some extra chitin perhaps, whereas in typical ephippia there is always a more or less abundant development of closely-set hexagonal prismatic cells which are quite independent of the original shell sculpture, and which, becoming readily filled with air, render the ephippium lighter than water. Nevertheless it must be confessed that the proto-ephippium just described goes far to bridge over the gulf which, until recently, seemed to separate the protective coverings of the resting eggs of the Daphnidæ from those of the Lynceidæ, etc.

What, it may now be asked, is the value of this very peculiar type of proto-ephippium from the point of view of the systematic subdivision of the troublesome family Lynceidæ? Considering the extremely close relationship of the three known species of *Leydigia* (*L. acanthocercoides* Fischer, *L. quadrangularis* Leydig, and *L. australis* Sars), it might have been expected that it would at least have given us another good generic character. Unfortunately this does not appear to be the case, for Professor Sars has placed on record that "no perceptible modification of the dorsal part of the carapace was ever observed" in females of *L. australis* carrying winter eggs (6, p. 43). Unless this observation rests upon a wrong interpretation of the nature of the eggs —which, however, scarcely seems possible, as Professor Sars distinctly says that they were easily distinguished from summer eggs by their dark-yellowish colour—the difference between *L. acanthocercoides* and *L. australis* in respect of the provision made for their resting eggs is a most remarkable instance of the wide gulf which may really separate two apparently closely allied species.

In the title of this paper I have called *L. acanthocercoides* a rare Water-flea, and that, I think, is quite allowable. It has been found so far by very few workers, and in nearly all cases the records are accompanied by statements that only a few specimens

were seen, or something to that effect. Professor Sars says that it has never been taken in Norway (8, p. 19), which in itself speaks much in favour of the idea that it is really a rare form, at least in Europe. It is just possible that this is the first time that it has been recorded in this country, for although Norman and Brady in their "Monograph of the British Entomostraca," (5,) mention a species which they refer to *L. acanthocercoides*, it is more likely that they actually had before them our commoner species *L. quadrangularis*. The latter species I have myself, in papers published before 1898, recorded as *L. acanthocercoides*, but that was done under the impression that the two forms were not distinct species. I do not now think there can be any reasonable doubt as to their distinctness, and it may be useful to other collectors in this country if I give the chief points which I rely upon for identification.

LEYDIGIA ACANTHOCERCOIDES, Fischer. Shell marked with more or less evident longitudinal ribs, and also with extremely fine longitudinal striæ. Terminal claws without a tooth at the base. Dorsal margin of body, between anus and abdominal setæ, with three or four little notches.

LEYDIGIA QUADRANGULARIS, Leydig. Shell without evident markings of any sort. Terminal claws with a small but distinct tooth at the base. Dorsal margin of body between anus and abdominal setæ without notches.

Fischer, in his original description of his *Lynceus acanthocercoides* (1, p. 431), specially refers to the extremely fine striæ between the coarser markings, and the presence or absence of this character seems to furnish an important means of separating the two species. My specimens of *L. acanthocercoides* have all exhibited these fine striæ, while I have never seen a trace of such striæ in *L. quadrangularis*. The presence of the little notches or crenations between the anus and the abdominal setæ is also, I believe, characteristic of *L. acanthocercoides*, although it has not previously been noticed. The dorsal margin in this region is quite unbroken in *L. quadrangularis*, (see Leydig (4) Taf. viii. fig. 59). It must be mentioned, however, that Sars has described a form from South Africa (8, p. 18), referred to *L. acanthocercoides*, which does not apparently exhibit the extremely fine striæ, at least they are not specially alluded to, nor does the dorsal margin of the body between the anus and the two long abdominal setæ

appear to be notched. I am, therefore, inclined to think that it may not actually be *L. acanthocercoides.*

In conclusion, I may be permitted to say, perhaps, that I am endeavouring at present to make a special study of ephippia and similar coverings of the resting eggs of the Cladocera, and that I shall be extremely grateful for specimens and information from any source.

Literature referred to in the foregoing Paper.

1. Fischer, S. "Abhandlung über einige neue oder nicht genau gekannte Arten von Daphniden und Lynceiden, als Beitrag zur Fauna Russlands." *Bulletin de la Soc. Imp. des Naturalistes de Moscou*, Vol. XXVII., Part 1, 1854, pp. 423–434.
2. Jurine, L. "Histoire des Monocles." Geneva, 1820.
3. Kurz, W. "Dodekas neuer Cladoceren." *Sitzungsberichte der Kaiserlichen Akad.*, Wien, Vol. LXX., 1874.
4. Leydig, F. "Naturgeschichte der Daphniden." Tübingen, 1860.
5. Norman, A. M., and Brady, G. S. "Monograph of the British Entomostraca." *Nat. Hist. Trans. Northumberland and Durham*, Vol. I., 1867.
6. Sars, G. O. "On some Australian Cladocera raised from dried mud." *Christiania Videnskabs-Selskabs Forhandlinger*, 1885, No. 8.
7. Sars, G. O. "Additional notes on Australian Cladocera raised from dried mud." *Christiania Videnskabs-Selskabs Forhandlinger*, 1888, No. 7.
8. Sars, G. O. "On some South African Entomostraca raised from dried mud." *Videnskabs-Selskabets Skrifter*, Math.-naturv. Klasse, 1895, No. 8. Christiania.
9. Schödler, J. E. "Ueber *Acanthocercus rigidus.*" *Archiv für Naturgeschichte*, Berlin, 1846, pp. 301–374.
10. Schödler, J. E. "Neue Beiträge zur Naturgeschichte der Cladoceren." Berlin, 1863.
11. Scourfield, D. J. "A very common Water-flea." *Illustrated Annual of Microscopy*, London, 1898, pp. 62–67.
12. Smitt, F. A. "Sur les Ephippies des Daphnies." *Nova Acta Soc. Scient.*, Upsala, Vol. III., 1859, pp. 37—50.

13. WEISMANN, A. "Beiträge zur Naturgeschichte der Daphnoiden," 2. Abhandlung. *Zeitschrift f. Wiss. Zoologie*, Vol. XXVIII., 1877.

EXPLANATION OF PLATE 11.

LEYDIGIA ACANTHOCERCOIDES.

FIG. 1. Female with resting egg and proto-ephippium which has only been partially moulted. × 85.

,, 2. Anterior portion of boundary line between proto-ephippium and unmodified portion of shell, showing the line of loosely connected cells. × 300.

,, 3. Lateral view of resting egg and proto-ephippium. × 85.

,, 4. Front view of the same. × 85.

,, 5. Inner cellular tissue which forms the "packing" between the egg and the outer coat of the proto-ephippium. × 250.

THE PRESIDENT'S ADDRESS.

By John F. W. Tatham, M.A., M.D.,

Fellow of the Royal College of Physicians.

(*Delivered February 17th*, 1899.)

At the close of my first year's tenure of the position which I owe to your good will, and certainly not to any merit of my own, I proceed to fulfil the customary duty which our regulations very properly impose upon the occupant of the presidential chair—namely, that of giving, at the appointed time, a formal account of his stewardship. In so doing, I shall not take advantage of my opportunity to inflict upon you a scientific dissertation; nor, indeed, should I have felt at liberty so to do in any case, even had the limited leisure at my disposal permitted of my making the necessary preparation. I have chosen rather to adopt a humbler course, and to offer you some brief comments of my own on a few of the chief developments of our Art which have taken place, or which have come under the notice of the Club, during the past year. This course, which I freely admit to have been determined quite as much by external circumstances as by personal choice, commends itself to my judgment for many reasons, and in our Club it has the important sanction of precedent.

Ever since its inauguration, some thirty-four years ago, the history of the Quekett Microscopical Club has been one of unchequered success. It was established, as our records tell us, "for the purpose of affording to experienced microscopists, as well as to students, regular and frequent opportunities of discussing those special subjects in which they are mutually interested, and also for promoting field excursions to the well-known collecting districts around the Metropolis."

It is my pleasing duty to announce that, throughout the year just closed, our Club has fully justified the anticipations of its promoters, under every one of the headings above mentioned. The

reports of our Secretary and Treasurer (which have already been presented to you) show that, speaking generally, our Club still continues to progress satisfactorily; but both these officers unite in accentuating the duty which we all recognise, of doing the utmost, individually, to repair the breaches in our ranks which inevitably occur as years roll on; and thus to maintain, for the future, that modest income without which our Club cannot continue in its present useful and prosperous condition.

For my own part, I cannot account for the fact that in a situation so central and convenient as that in which we are privileged to hold our meetings, our membership list still continues to be so small, and this in spite of the persistent efforts which many of us make to increase it. Our annual subscription surely is sufficiently low; our Council exact no additional fee on admission; our members have access to one of the most valuable natural history libraries to be found anywhere, as well as to a trustworthy and varied assortment of microscopical preparations by the best mounters of the present as well as the past; and all these treasures are available for the inspection and use of members, on reasonable conditions. When it is remembered, further, that each member receives, without additional charge, two journals in the course of the year, containing full accounts of our proceedings, and either abstracts or detailed reprints of such papers as are deemed worthy of record by our Council; that our Excursion Committee arrange annually about a dozen visits to places of interest to naturalists; and, what is not less important, secure on economical terms refreshments and railway tickets without trouble to individual members,—when all these advantages are offered, in return for a subscription which is merely nominal, it is, I repeat, surprising that naturalists generally do not avail themselves in greater numbers than at present of the membership of our Club.

Referring, in the first place, to the improvements which have taken place since our last annual meeting in the practical application of the microscope, it is satisfactory to know that, if there is no startling discovery to announce within that period, nevertheless a considerable amount of substantial, if unobtrusive, progress has been made. The honorary Editor of our Journal, than whom no living man has done more on behalf of practical microscopy, has enriched our pages with two more of his excellent

papers on diatom structure, and has thus added to our knowledge not only of the morphology of these interesting organisms, but of the methods by which their structure can most profitably be investigated. To Mr. Nelson the discovery of new methods for the interpretation of microscopical detail is a constant and an engrossing study, and I am sure that those who, in common with myself, have been allowed the privilege of witnessing his methods of work, will agree with me in admiration of his untiring devotion to that branch of science of which he is so accomplished a master.

Mr. Nelson has also contributed to our Journal part 2 of his essay, undertaken at the special request of the Council, on the evolution of the microscope, which brings down the history of that instrument to the year 1744. When completed, this will form one of the most interesting essays that have hitherto been communicated to the Club. A very useful and thoroughly practical paper is that contributed by Mr. Rousselet on "Micro-Cements": coming from a gentleman so thoroughly versed in the mounting of a peculiarly refractory class of organisms, this paper will be read with interest by those whose studies lie in a similar direction. Several other papers and "notes" have been contributed to the Club during the year, and full descriptions of them will be found in the Journal.

The question of "brass and glass," as we term it, is always a popular one with the Club, and, according to precedent, I beg leave to offer a few remarks upon it.

We hear a great deal nowadays about a very common type of instrument to which the title "student's microscope" has been accorded, with more liberality than justice, as it seems to me. The instrument of the class to which this name has been given, consists invariably of a small stand, approximating more or less closely to the Continental model, with a short tube, of small diameter, a stage inconveniently near the table, and where a condenser is included, this is generally of the so-called Abbé chromatic form, which is either made to slide in a rigid fitting or is supported on a modified form of sub-stage.

The ingenuity which has been expended on this type of stand is remarkable; most, though not all, of our English firms having competed with one another to produce the most attractive instrument at a given price. But if the type itself is not everything

that can be wished, it would be unfair to blame the opticians, for they have simply catered for a public want. The demand comes mainly from the teachers in the laboratories of our medical schools, who seem almost with one accord to have capitulated to the Continental fashion, and to have advised their students accordingly.

Now it must at once be admitted that the better forms of small stand are very handy to use, and that they allow of the manipulation and examination of specimens in fluid whilst lying horizontally on the stage.

There is no doubt that they serve their purpose well, and it would be hopeless, if indeed it were desirable, to attempt to displace them by instruments of larger build. It should always, however, be insisted upon that instruments of this type must be constructed as simply and as rigidly as possible. They should be fitted with a large, firm stage, preferably of glass or of some other material that will resist the action of corrosive and other fluids; and sufficient space should be given between the pillar and the central opening of the stage to allow of the use of large culture plates, and of ordinary apparatus for dissection. There should always be a substage fitting, perfectly centered to the optic axis of the microscope tube; but it is doubtful whether it is worth the expense to mount the illuminating apparatus for instruments of this kind on a centering and focussing substage. Such instruments as these should be provided in all cases with a double nosepiece. This type of microscope is common in the English market at the present time, and appears to meet with general approval. Several instruments of like description, carefully and substantially made, have been submitted for the inspection of the Club during the year: for example, the "Fram" microscope of Messrs. Watson, the "Scientific-Student" microscope of Messrs. Beck, and some others. But I have occasionally observed, especially of late years, a tendency to increase both the complexity and the costliness of these instruments, and this to such a degree as to render them unsuitable for the purpose for which they were designed, and which alone they are fitted to serve—namely, that of dissecting, or laboratory working instruments. I have met with stands, not exceeding ten inches in height, fitted with binocular bodies, triple or even quadruple nosepieces, elaborate mechanical stages, swinging or so-called

"turn-out" substages, intended to carry a chromatic or other condenser, paraboloid, spot lens, polariscope, and a host of other apparatus such as would be suitable only for a full-sized, complete stand of the English model. I confess that when I see small stands of this class encumbered with milled heads and other projections, both above and below the stage, and overweighted with complicated and costly accessories, I am at a loss to understand how they can be used to any good effect by the average student. It cannot, therefore, be too strongly asserted that instruments of the kind I have now been considering are, in their nature, working or mounting instruments only, and that any attempt to raise them to a higher position, by the addition of elaborate mechanical appliances, can only result in failure and disappointment.

But there is another type of instrument, seldom met with now, but which in my early days used to be called the Student's microscope, and, in my opinion, much more appropriately. The stands I refer to were of full English size, and of first-class material * and workmanship. They were supplied by their makers in a plain, elementary form; being fitted, in the first instance, with nothing more than coarse and fine movements to the body, simple square stage and sliding bar; but they possessed the very obvious advantage that they were capable of being built up into instruments of great completeness, according to the wish or means of the purchaser, and having been originally designed accordingly, they were not overbalanced by subsequent additions. Thus a mechanical stage, with universal movements, a rack-and-pinion focussing substage, with centering and rotating adjustments, could be adapted, binocular bodies could be added if desired, and all other apparatus required by the most accomplished microscopist. I believe that I am not awarding praise unfairly when I say that the firm of Ross & Co. were the first to introduce this excellent plan, which was subsequently adopted for a brief season by most of the other London opticians. I purposely bring into prominence what is now—unfortunately, as I think—a matter of ancient history, because I am confident that

* I am afraid that the brass of which many of our stands are made nowadays is sadly inferior to that which used to be employed for that purpose; much of it is so soft that, as a brass-worker once phrased it, "You can almost bite it through with your teeth."

the present rage for a so-called complete microscope of the small Continental pattern will eventually pass away. I believe, further, that at no distant date the instrument for the study, as distinguished from the laboratory, will be a solidly built English stand of full dimensions, mounted on a heavy tripod base, and differing little in general form from that type * which many of us in this Club know so well how to appreciate. To meet the present fashion of constructing objectives without correction collar, it is necessary that such an ideal instrument as I am projecting should be fitted with a draw-tube capable of considerable extension by rack and pinion. The substage also should, I think, receive more attention than is now generally devoted to this important part of the stand. It should be much more substantially constructed, and its movements should be more delicate and steady than is the case at present with any but the most costly instruments. It must be remembered that the substage of a full-sized stand has to support and focus, without tremor or oscillation, a considerable weight of apparatus. My own substage, for example, fitted with an achromatic condenser, which, by the way, is always in position, weighs not less than 1 lb. 6 oz. Unless, therefore, the mechanism which sustains and moves this load be substantially and accurately constructed, it is obvious that the strain will inevitably disarrange the necessarily delicate adjustments of the instrument.

In my opinion, which has not been formed without consultation with experienced workers in this metal, it is in the construction of the substage and the apparatus supported thereby, as well as in that of the double or triple nosepiece, that aluminium, as a much lighter substitute for brass, seems to promise to be useful. That substages, and indeed complete microscopes of great perfection, can be made of this metal, or rather of one of its alloys, has been abundantly shown by Messrs. Swift at one of our recent meetings; and although opinions may differ as to the advisability of constructing any but a portable stand, like the one shown by Mr. Swift, exclusively of aluminium, it will, I think, hardly be contended that anything but advantage could result from the use of this

* The instrument I refer to is Powell & Lealand's No. 1 Stand. This is the type to which all recent improvements in English stands have approximated, as far as I am aware.

metal in the manufacture of the substage and the apparatus which it supports.

Turning now to the optical portion of the microscope, there is no doubt that within the last few years most important advances have been made towards perfection. Even during the last twelve months, or at any rate within the last two years, more than one optician has added a contribution to the resources of the microscopist. By the use of several different varieties of Jena glass opticians are daily vieing with one another in the perfecting of apochromatic objectives without the use of fluorite in their construction. Only recently a new glass of $\frac{1}{10}$-inch focal length and of 1·30 N.A. has been constructed by Leitz, of Wetzlar. Several of these glasses, constructed for the long as well as for the short tube, have found their way into this country, and from the specimens I have seen I am bound to speak highly of their performance. When used with a malachite green screen, the best of these glasses give an image of remarkable brightness, capable of standing fairly high eyepiecing, without appreciable loss of definition. This glass is sold at a very moderate price: in fact, it is, as far as I know, the cheapest glass of the kind hitherto produced. Another objective, which, in its present state of perfection, is new at any rate to me, deserves special mention here. It is a $\frac{1}{12}$th of hard glass, specially constructed for use in hot climates, by Reichert, of Vienna. It has an aperture rather greater than that of the $\frac{1}{10}$th first spoken of—perhaps of about 1·35. This objective also is one of exceptional merit; it is a very strong resolver, and produces an image of great purity and brilliancy, which bears eyepiece amplification remarkably well. It has, however, in my judgment, the important defect that it is adjusted only for a very short tube. If this objective could be corrected for the ten-inch tube, and made to work as well on this as it does on the short tube, I am sure that it would be found to compare favourably with the majority of fluorite apochromatics, although the latter cannot be purchased for less than double the price which is at present charged for this objective.

I believe that I am correct in stating that the achromatic condenser is regarded, by competent authorities, to be *the one accessory* which is absolutely essential, if the compound microscope is to occupy any better position than that of a costly toy. And

yet it is certain that comparatively few microscopists realise how much there is to learn before full advantage can be derived from its employment. To prove this I may be permitted to recount an item of personal experience; premising that I have used the accessory in question continuously for a period of at least twenty-five years.

One evening, only a few months since, I was examining, with Mr. Nelson's assistance, a new and very perfect apochromatic condenser recently constructed for me by Messrs. Powell & Lealand. Finding that on examining a certain test slide, which was a very thin one, I was unable to obtain an unbroken cone of light nearly large enough to fill the back lens of an objective of the same numerical aperture as that of the condenser itself, I hastily came to the conclusion that the condenser was at fault, and resolved to return it to the makers for alteration. From his riper knowledge, however, my host was able to teach me that the fault lay—not in the condenser, but in myself. Under his direction I learnt to appreciate fully, for the first time, the fact that no condenser can be adjusted to give a perfect cone with more than one definite thickness of slip. And this was shown to be the case with the condenser in question, for on changing the glass slip, which was perhaps less than $\frac{1}{30}$-inch thick, for one of double that thickness, the back lens of my objective, an apochromatic of 0·95 N.A., was instantly filled with an aplanatic cone of bright light, and the resolution of the test was thenceforth accomplished with ease. The practical lesson, which this single experience has taught me, is that good resolution and perfect definition can be obtained, with even the most perfect appliances, only when glass slips are used which are of the proper thickness, and which approximately fill up the space intervening between the front lens of the condenser and its focal point; and as the object under examination is, or should always be, in the exact focus of the condenser, it is easy to arrange the thickness of the glass slips accordingly. When difficult or exceptionally transparent diatoms are under examination the correctness of the foregoing contention readily becomes apparent. For example, I have very recently been examining a specimen of *pleurosigma macrum*, mounted in Styrax, on a very thin slip. Forgetting the experience already referred to, I spent a considerable part of one evening in fruitless attempts to obtain resolution of this

diatom, although I knew the feat to be well within the capacity of the lens employed. Thinking that my failure was due to the exceptional transparency of the silex of my diatom, mounted as it was in Styrax, I temporarily gave up the attempt. Subsequently, however, on "building up" the slide, by cementing to it another of equal thickness, so as to make the two slips together equal to about $\frac{1}{15}$ of an inch in thickness, I was rejoiced to find that my difficulty had vanished, for the macrum was resolved into "checks." To any one who is still sceptical as to the necessity of adjusting the thickness of his glass slips to the focal length of his condenser, I recommend this experiment as a useful object-lesson. As a matter of fact I have decided to build up every one of my test slides in the manner above indicated, and in future I shall use none but carefully selected slides of proper thickness for the mounting of test objects.

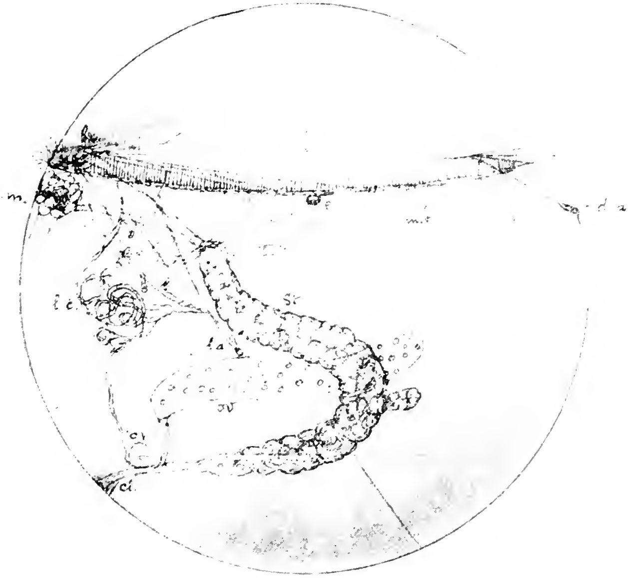
Within the last few days I have been permitted, through the kindness of a friend, to examine an achromatic condenser of entirely new formula, computed by Mr. Conrady, of London, on the oil immersion principle. It transmits an aplanatic cone of about 1·35 N.A., and works through a fairly thick glass slide. I have as yet had only one opportunity of examining this condenser, but it appears to me to be one of great promise; it is beautifully corrected spherically as well as chromatically, and considerably increases the resolving power of wide-angled apochromatics on fine-lined tests. I hope to see further developments of the achromatic condenser, at the hands of this talented optician.

It now becomes a pleasing duty to acknowledge my personal indebtedness to my fellow-members of the Club for the uniform courtesy and support which I have received during the year of office which terminates to-day. To our honorary secretary and honorary treasurer especially my thanks are due, for it is to their unstinted devotion, both of time and energy, to the affairs of the Club that is due in very large measure its present condition of usefulness and success. Our honorary editor, too, has given me constant assistance and advice; and to his ability and sacrifice of valuable time we are all indebted for the exemplary editing and publication of our Journal. I beg also to tender my cordial thanks to our honorary librarian, our honorary curator, our honorary reporter, and to my other colleagues of the Council, for their kindness and support during my past term of office.

It only remains, gentlemen, for me to thank you for the honour you have conferred upon me by electing me as your president for yet another year. It is an honour which, much as I appreciate it, I did not seek, because of the impossibility of my devoting to the duties of the position such time and attention as it appears to me to deserve. Since, however, you have chosen to re-elect me, notwithstanding such disabilities on my part, I can only assure you that I highly prize this renewal of your confidence, and that within the limits imposed on my leisure by engagements elsewhere, I will do all in my power to further the interests of our Club.

Note on a Mounted Slide of Trochosphæra Solstitialis, a Spherical Rotifer, exhibited at the Club's Meeting on February 17th, 1899.

By C. F. Rousselet, Curator R.M.S.



The above diagrammatic sketch will give an idea of this remarkable rotifer, which has not yet been found in Europe. This is the first time that a mounted slide of it is exhibited, and that it is seen at all in the flesh in England.

In October 1859 Professor Semper discovered in some ditches intersecting rice fields in the Philippine Islands a spherical rotifer, which he named *Trochosphæra æquatorialis.* In this animal the ciliary wreath runs round the equator, dividing it into two hemispheres exactly alike. A translation of Professor Semper's paper on his discovery was published in the "Monthly Microscopical Journal" of 1875, vol. xiv., pp. 237—245.

For thirty years nothing more was seen of this animal, until Surgeon Gunson Thorpe had the good fortune of finding it again in January 1889 in Fern Island pond of the Botanical Gardens at Brisbane, Australia, and of also discovering the male, which he described in a paper published in the "Journal R.M.S.," 1891, p. 301.

In August 1892 Surgeon Gunson Thorpe was stationed in Chinese waters, and his ship having gone up the Yangtsze Kiang as far as Wuhu, some two hundred and sixty miles from the coast, he there examined the water of some irrigation creeks and ponds, and discovered a new species of *Trochosphæra*, in which the ciliary wreath encircles the body as the Tropic of Cancer encircles the earth, dividing it into two unequal segments. He therefore named his species *T. solstitialis*, and described it in a paper which appeared in the "Journal R.M.S." of 1893, p. 147.

In August 1896 the same species was found by Dr. C. A. Kofoid in the Illinois River, in America; and last summer a few examples were again taken by Mr. H. S. Jennings in a pond close to Lake Erie, America; and this gentleman has been good enough to send me the mounted specimen, which he prepared according to my method, now exhibited for the first time in this part of the world.

The anatomy of the animal is extremely simple and beautifully displayed, all the organs, usually so indistinct and closely packed together in rotifers, being here spread out and suspended in the transparent sphere in the most delightful manner. The ciliary wreath encircles the sphere above the middle, leaving the usual dorsal gap, and dividing it into two unequal segments, the larger oral segment containing all the organs, and the smaller aboral segment having nothing at all. Close below the wreath on the ventral side is the mouth and mastax; a long thin œsophagus leads into the alimentary canal, which is suspended in the centre of the sphere. This canal has about its middle a single small knob-like outgrowth or gland, makes half a corkscrew turn, and ends in a cloaca which apparently opens also on the ventral side. Now, in all other Rotifers without exception having a cloaca this organ opens on the dorsal side. Surgeon Gunson Thorpe was so impressed by this anomaly in his new species that, rather than admit that this was a new departure, he preferred

to declare that the side on which both the mouth and cloaca open is really the dorsal side of the animal. But then the usual dorsal gap in the ciliary wreath and single dorsal antenna, which are both very distinct, would in this animal be situated on the ventral side. I think, however, there is a better way out of the difficulty, and that the cloaca is only apparently ventral when in reality it is dorsal. By comparing *T. solstitialis* with a few other rotifers the true relation of this organ will be shown. *Asplanchna priodonta* has no intestine, but it has an uro-genital cloaca, which also opens apparently on the ventral side of the animal. *Asplanchnopus myrmeleo* is like *Asplanchna* in this respect, and has in addition a foot protruding on the ventral side; the uro-genital cloaca also appears to open on the ventral side, but closely behind and dorsal to the foot. *Notops hyptopus* has a ventrally situated foot and an ano-uro-genital cloaca again situated apparently on the ventral side, but dorsal to the foot, which is generally admitted to be the dividing line between the dorsal and ventral side of a rotifer. It will be seen, therefore, that in the rotifers having no foot there is no clear indication as to where the dorsal side begins; and I think the best explanation in the case of *Trochosphæra solstitialis* will be to say that the ventral side ends just before the cloaca, and to call the whole tract, from the gap in the trochal wreath to the cloacal orifice, dorsal. In this way the cloaca and all other organs will appear in the usual position which obtains throughout the class.

The flat ribbon-like ovary is suspended between the body wall and the stomach, and opens by a thin-walled oviduct in the cloaca. The lateral canals are attached on each side close to the walls of the sphere, and appear to open in a small contractile vesicle; their apparent connection with the nerve threads of the lateral antennæ does not appear to me to be real or organic, but only accidental. Two red eyes, with crystalline lenses, are present, situated on the ciliary wreath in a line at right angles to the mouth. The nervous system is very distinct, and can be beautifully studied in this animal; the brain ganglion is seen just above the mastax, sending long and short nerve-threads across the body cavity to the dorsal and lateral antennæ, to the ciliary wreath, the eyes, and all other organs. Two long and two short gastric glands attached at the apex of the stomach, and four or five pairs of small muscular bands arranged just below

the ciliary wreath, by means of which only this zone can be slightly contracted, complete the summary description of *Trochosphæra solstitialis.* In size and shape it is like a young volvox globator, with perfectly transparent integument. I understand Dr. Kofoid has in preparation an exhaustive paper on this very interesting rotifer.

References in the Drawing.

br.—brain.
cl.—cloaca.
c. v.—contractile vesicle.
d.a.—dorsal antenna.
e.—eye.
l.a.—lateral antenna.
l.c.—lateral canals of water vascular system.
m.—mouth and mastax.
m.b.—muscular bands.
n.—nerve-threads.
ov.—ovary.
st.—stomach and intestine.

October 21st, 1898.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations were announced :—

"The Stockowners' Indebtedness to the Microscope"	From Mr. C. J. Pound.
"The Tailless Batrachians of Europe"...	„ Mr. R. Knight.
"Journal of the Royal Society of New South Wales"	„ The Society.
"Report of the Missouri Botanic Garden"	In exchange.
"The Botanical Gazette"	„ „
"The American Monthly Microscopical Journal"	„ „
"Transactions of the Canadian Institute"	„ „
"Journal of the Royal Microscopical Society"	„ „
"Proceedings of the Royal Society" ...	„ „
"Proceedings of the Geologists' Association"	„ „
"Bulletin of the Belgian Microscopical Society"	„ „
"La Nuova Notarisia"	„ „
"Catalogue Générale des Diatomées"...	By subscription.
"Catalogue of Rotifers of the Lake of Geneva" (Part I.)	From Dr. Weber.

The thanks of the Club were voted to the donors.

The Secretary said the members would regret to hear of the death of Mr. Charles Nathaniel Peal, who had been a member of the Club since 1873. Although of late years unable to be present at their meetings, Mr. Peal was always much interested in their proceedings, and was actively engaged in much that went on in his own neighbourhood, especially in connection with the Ealing Natural Science and Microscopical Society, of which he had been Treasurer since its foundation.

Messrs. Beck exhibited four new microscopes which had been designed to meet the want of a good and cheap instrument for student's use. They also exhibited an improved form of centrifuge, much simpler in construction, and therefore less costly—though not less efficient—than the similar instrument shown on a previous occasion.

The President said he had not had an opportunity of examining these instruments, but they appeared to him to be a very useful addition to the many kinds of student's microscopes which had already been brought out.

Mr. Karop thought they were very nicely constructed, but it seemed to him that it was rather a disadvantage to have the mirror so rigidly fixed. He thought it would be better to have had this movable.

Messrs. Watson also exhibited a new pattern microscope of the student's type, possessing a firm stand and a body tube, which could be extended from 6″ to 10″, so as to be used for objectives corrected for either the Continental or English tube lengths.

The President said this appeared to be a microscope of much the same class as the others which were shown, and it also appeared to be very well made.

Mr. Karop said they were much indebted to Messrs. Beck and Messrs. Watson for sending these instruments for exhibition, but he noticed they had retained what he thought a great evil in a microscope stage—spring clips, which were often extremely inconvenient and in the way, knocking off cover glasses, etc. He thought a sliding-bar was far preferable.

Mr. Watson Baker said he had a sliding-bar in his bag which he ought to have shown, as it would fit any of their student's microscopes; the spring clips merely had to be removed, and the sliding-bar put on.

The thanks of the Club were unanimously given to Messrs. Beck and Watson for their exhibits.

Mr. George Massee gave a description of the Fungi usually to be found in Epping Forest, and which it was expected they would have collected at the special excursion of the Club on October 8th. The continued dry weather, however, had been very prejudicial to the growth of this class of vegetable organisms, so that very few were actually found on the occasion.

The President said they were greatly indebted to their friend

Mr. Massee for his very instructive and interesting communication, and they must all have been struck by the clear manner in which his knowledge on the subject had been imparted to them. He was also surprised to find that all they had heard that evening related to only one group—the Ascomycetes. He did not know what proportion this group bore to the whole, but it would naturally occur to those who had listened to Mr. Massee that evening that if so much could be said of one group only, how much could be said upon the whole family?

Mr. T. Simpson said Mr. Massee had told them that the remedy against the attacks of these Fungi was very simple, and well known to horticulturists; but not being a horticulturist he should very much like to know the remedy. He was a grower of chrysanthemums, and naturally did not like to see his plants so disfigured; but what he could not quite understand was that he often found one plant very badly affected, whilst others near it were not so. This he also found to be case with the rose mould—one plant would be badly attacked, but others near it would be free; but what he wanted to know was how best to prevent the spores from being communicated from one plant to another. He hoped Mr. Massee would be able to help them in the matter.

Mr. E. T. Newton said he was quite a learner as regarded this subject, but he should like to express his great gratitude to Mr. Massee for the extremely interesting lecture which he had given them. He was one of the party who went to Epping Forest on the occasion referred to; but although the weather would not do what they wanted, and it would not rain, they must now feel that they were compensated for their disappointment, inasmuch as the absence of rain—although it had caused an absence of Fungi—had not prevented them from having an abundance of information.

Mr. Karop understood that the spores which fell upon the leaves sent their mycelium into the tissues of the plant through the stomata, which were generally on the under side of the leaves. It seemed to him that the spores would naturally fall upon the upper surface. Would this have to do with the spread or prevalence of the fungus?

Mr. H. Groves said, as regarded the earlier (lower?) types of Fungi which Mr. Massee had called old-fashioned, he thought what

had been said concerning them had gone largely to show that these very elementary forms of Fungi were equally capable of carrying on their existence as any of the later forms; so that he was rather sorry to hear him disparage them, because they seemed quite as capable of carrying on the business of life as the ascomycetous forms.

Mr. Massee, in reply, said, as regarded the horticultural difficulty, horticulturists, as a rule, did not anticipate; but when the disease came, then they wanted to do everything. Of course it was then too late to do anything. The thing to do was to anticipate, and one or two syringings in the spring would in most cases prevent the after trouble. Then gardeners would always crowd these things together, with the same result as overcrowding in the case of infectious disease; although, as in a case where one member of a family had small-pox, it would sometimes happen that the others would not take it. To anticipate a possible outbreak it would be a good thing to syringe with some solution, such as potassium sulphide, and wherever it was practicable to grow a mixed crop. It was better to have one free than ten diseased; and if the crop was mixed a disease which affected only one particular sort would be more isolated, and seven out of ten might be saved. He did not think that spore diffusion was altogether a matter of gravitation; for being so infinitely fine, like the dust in the sunbeam, they practically ignored gravitation. In the case of the lower forms they did very well in their way, but there were amongst them about six hundred species confined to a small geographical area; whereas they had at least fifty thousand of the others spread all over the world. The thing which had the greatest area, and could keep the others down, was what he looked upon as having hit the mark.

Mr. Massee's subject was well illustrated by diagrams and specimens, and by a series of preparations shown under a number of microscopes in the room.

On the motion of the President, a cordial vote of thanks was given to Mr. Massee for his most interesting paper.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated.

November 18th, 1898.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. M. W. Liston, Mr. W. H. Harris, Mr. Otto Hofmann, Mr. Frederick Armitage, Mr. A. Carnall, Mr. L. O. Grocock, Mr. George Massee, Mr. George Nicholson, Mr. E. S. Salmon, Mr. T. J. Smith, Mr. W. D. Colver, and Mr. M. Johnston.

The following donations were announced:—

"Science Gossip"	From the Publisher.
"Journal of the Royal Microscopical Society ...	" " Society.
"The Botanical Gazette"	" " Publisher.
"Catalogue of Diatomaceæ" ...	Purchased by subscription.

The thanks of the Club were voted to the donors.

The Secretary announced that their old friend, Dr. M. C. Cooke, was giving up the whole of his scientific collections, and had sent a large quantity of Diatomaceous material for distribution to any members who wished to have some. A list of the localities from which the deposits were obtained was laid on the table, and members desiring samples were asked to apply to the Secretary by post, enclosing a stamped and directed envelope. About twenty gross of unground glass slips were also at the disposal of any members who cared to apply for them. A catalogue of a large number of works which Dr. Cooke had for disposal, also many original drawings and plates of Algæ, etc., could be seen by any one desirous of purchasing any of them.

The Treasurer said, as they were nearing the end of the year, he thought it might be well to remind the members that 44 of their number had omitted to pay their subscriptions for 1898.

Mr. Karop regretted to have to announce the death of one of their members—Mr. Latimer Clark—which had occurred since their last meeting.

Mr. E. M. Nelson said that Mr. Latimer Clark was a very well known engineer, and amongst other things he invented the

pneumatic despatch, which was at present largely used by the Post Office for blowing packages of telegrams through pipes. Although he only became a member of the Club in 1896, he was by no means a novice in microscopic work. When a very small boy a friend took him to see Mr. Clark's microscope, and he believed it was the first achromatic microscopic he ever looked through. What he then saw made a very strong impression upon him, which the intervening time had not effaced. The objects which he remembered Mr. Clark showed him were the archegones of some living mosses taken from the garden wall.

A paper by Mr. W. H. Harris, "On Some Marine Vegetable Organisms invading Calcareous Organic Remains," was read by Mr. J. G. Waller, the subject being illustrated by numerous photographs exhibited on the screen by Mr. E. M. Nelson.

The President said they could not complain that they had been that evening without a definitely scientific paper, and he thought they were not only very fortunate in having such a paper, but also in having Mr. Waller to read and explain it, and in having Mr. Nelson to exhibit the slides.

Mr. Bryce asked what magnifying power was required to show these organisms properly? When at the seaside he should like to be able to know how best to see them.

The President also asked if Mr. Waller could tell them what was the nature of these organisms?

Mr. Waller said that Kolliker thought them to be of the nature of fungi, and Dr. M. C. Cooke expressed the same opinion when the subject was before the Club some years ago.

Mr. Michael inquired whether the very beautiful and interesting pictures which had been shown were supposed to represent the organisms themselves, or merely the channels which had been made by them?

Mr. Waller said the pictures showed the channels, some of them done, others partly done, with the process still going on.

Mr. Michael said it struck him as rather a remarkable proceeding to name a large number of species in this way, simply from certain markings which they were supposed to have made. He was of course aware that they were in the habit of naming a thing in Geology from its cast, and they named a Phytoptus from its gall; but they had not yet got to naming a bird from its nest, and in the instances before them they appeared to have

an identification merely from the channel which had been dug out. He did not think it was necessary to suppose that the same organism always made the same sort of channel, and he did not know that a return to this mode of identification of species would be altogether an advantage.

Mr. Waller said that he had named his own species from actual living specimens. He had a number of slides of these, and would show them at one of their gossip nights.

Mr. E. T. Newton said he should not be prepared to go so far as Mr. Michael in saying that they ought not to give names to things unless they were sure as to what they were, and he hardly saw that any great disadvantage arose from giving names to things for the purpose of future identification. For instance, a person might find a piece of a fossil tooth, and this being the only one found, so far as he knew, he might call it species A. Another person would find one which seemed to differ, and he would call it species B; whilst a third person might find a more complete specimen which combined both A and B, and in this case the second name would have to go. It seemed to him a necessity to give separate names in this way to apparently different species, until a time came when they could put the two together; and until they could establish their identity he did not see what other course they could take. The difficulty in the cases before them seemed to be that of deciding what had really made these markings. Were they made by Fungi? Was it probable that they were caused by Algæ? Or was it not possible that some of them were the result of chemical decomposition? And again: Was it not possible that some other organism might have made the holes, and the one found there had only come to live in them? He congratulated the Club upon having had this paper brought before them.

Mr. Michael did not think Mr. Newton had quite caught his point. In the case of a tooth, however small a piece it might be that was found, it was a portion of a creature; whereas in the case before them they had no portion of a creature, but only the burrow, which it was supposed some creature had dug out, and this seemed to him of very little value as a means of classification.

On the motion of the President, the cordial thanks of the Club were voted to Mr. Harris for his paper, to Mr. Waller for reading

and explaining it, and to Mr. Nelson for his kindness in showing the slides.

Mr. Karop said that Messrs. Beck were exhibiting in the room two slides of *Amphipleura pellucida*, one under a $\frac{1}{12}''$ objective of numerical aperture 1·0, and the other under an objective of the same magnifying power, but with an aperture of 1·25. The former just showed signs of resolution, but the latter resolved it completely.

The Secretary announced that the annual *soirée* of the Croydon Microscopical Club would take place on November 23rd, and members of the Quekett Microscopical Club were invited to exhibit thereat; also that, with a view of making the meetings more widely known, the Committee had ordered some cards to be printed announcing the date of next meeting, and, in a space left for the purpose, the titles of the papers to be read. Many of the opticians had promised to exhibit these cards in their establishments, but the value of such announcements would largely depend upon timely notice being sent to him of the matters it was intended to bring forward at their meetings. In many cases he only received notice as to the titles of papers, etc., a day or two before the meeting, and under those circumstances it was of course impossible for any announcements to be made.

Announcements of the meetings of the Club for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

December 16th, 1898.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. William J. Ford, Mr. Archibald French, Mr. W. H. Williams, and Mr. Arthur Whitcombe.

The following donations were announced, and the thanks of the Club were voted to the donors:—

"Journal of Applied Microscopy" ...	From the Publisher.
"Proceedings of the Manchester Literary and Philosophical Society"	" " Society.

"Proceedings of the Geologists' Association"	From the Society.
"Report of the Ealing Natural Science and Microscopical Society	" " "

Messrs. Swift exhibited a microscope on their four-legged tripod model, but made of aluminium throughout, with the exception of the rackwork, screws, and wearing surfaces, these latter being of steel, or faced with thin steel plates. All the fittings, as eyepieces, sub-stage condenser, etc., were also of aluminium, including the entire mount of the objective shown, which Messrs. Swift believed was one of the first so constructed. The President thought the use of aluminium for the objective mount was greatly to be commended, as it would be a great saving of strain on the fine adjustment, in some forms at least.

Mr. Karop believed that one drawback to the use of aluminium was that it was a very expensive metal to work—the screws and racks also had to be made of some harder metal. He thought this difficulty might be met to some extent by making an alloy of aluminium with some other metal which would give it greater hardness, while retaining some of the advantages of lightness.

Mr. M. Swift said this could no doubt be done, but as soon as they began to get harder alloys they got them heavier.

Mr. Michael said it was easy to make an alloy of aluminium, which was an exceedingly hard metal, but it was not exactly a tough metal, at least so he found some years ago when he was considering the possibility of making a microscope of this kind. He thought, however, that the great value of this light weight was where they wanted a travelling microscope—for it did not much matter in the case of one which was to be used at home; but if there were to be steel parts introduced, were there any means taken to prevent these from rusting?

Mr. M. Swift said the working parts were always lubricated with oil, and this was found sufficient to prevent rust. He might also say that when Mr. Michael approached them some years ago on this subject, the aluminium which they were then able to get was much more difficult to work than the kind they were able to obtain now.

The thanks of the meeting were voted to Mr. Swift for his exhibit.

Mr. Schroeder read a paper in which he described a new form

of projection microscope, and also the lamp by which it was illuminated. By means of drawings on the blackboard he illustrated the combination of lenses used to secure the needful corrections, and stated that with the electric lamp employed, a source of light was obtained not exceeding half a square millimeter, which enabled him to show objects with perfect sharpness and in a way never before accomplished, up to a magnification of 10,000 diameters.

Mr. E. M. Nelson said Mr. Schroeder had pointed out very clearly the necessity for illumination by a small point of light. As regarded the magnification of 10,000 diameters, the light became so greatly enfeebled that the object was practically invisible to any one who was not close up to the screen. It would be obvious that if the original source of light was equal to 10,000 candle power, and the image was magnified 10,000 times—to say nothing of 10,000 diameters—they would only get a light equal to one candle-power on the screen. The lantern microscope would always be found useful for showing objects to a small number of persons round a small screen, but if they wanted to show the object to a large number at a distance they must fall back upon the lantern slide. Mr. Schroeder had shown them how to get a great deal more light into an objective than they had been able to before—but 10,000 diameters upon the screen was a thing which he confessed he was rather doubtful about.

Mr. Lewis Wright did not think it was easy for people who had worked independently in matters of this sort to discuss them on the spur of the moment. He had been able, as others had, to do something in this direction himself, and was sure that all of them had reached the same point as to the necessity of getting a small and at the same time an intense light; and if Mr. Schroeder could give them a lamp such as he described, he would have done a very great service to all who were working with the projection microscope. All the defects of the arc lamp which had been pointed out were not, however, quite so bad as stated, because when the carbons were put in an inclined position they could in this way get the top crater to the front and could use this as their source of light; but there was the flickering and shifting about of the flame which proved so troublesome, so that if Mr. Schroeder was able to get such a light as he had described it would be of great service. It seemed, however, not to be strictly an arc, but was

practically a very intense incandescence. When they remembered that 10,000 diameters meant 100 millions of times dilution, it was obvious that a very intense light was essential. He had been very much interested by Mr. Schroeder's paper, and especially with his description of the electric lamp.

The President was sure the members would pass a hearty vote of thanks to Mr. Schroeder for what they would agree was a very valuable and interesting paper.

Mr. E. M. Nelson read a paper "On the Structure of the Nodules of Pleurosigma," the subject being illustrated by photographs and drawings shown upon the screen.

The President said the subject of high-power definition and illumination was one which Mr. Nelson had made peculiarly his own, and the members of the Club knew how to prize any communications of this kind from him.

Mr. Moreland said that until Mr. Nelson called his attention to the matter he had not noticed the special points referred to, and must therefore accept his statements; but as regarded his deductions, he thought they hardly had enough information to enable them to come to a definite conclusion, and he thought before doing so they would have to examine more carefully the other forms in which the central raphæ terminated in a similar way.

Mr. Mainland said that some years ago he worked out the structure of some diatoms found in tooth powder, and he then particularly observed the nodes of the pipes curving in opposite directions.

The President said he felt sure they would pass a hearty vote of thanks to Mr. Nelson for his interesting paper. Recently he had been doing a little work with Quinidine as a mounting medium, and he had found that the nodules assumed all sorts of different positions whilst this medium was cooling. It was an interesting matter which had been brought before them, and he should be glad to hear that other members were taking it up.

A vote of thanks to Mr. Nelson was unanimously carried.

Notices of meetings, etc., for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

January 20th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Messrs. Bird, Taylor, Foucar, and Gardner.

The Secretary reminded the members present that their next meeting would be the Annual Meeting of the Club, at which the officers and Council would have to be elected for the ensuing year.

The nominations made by the Committee were as follows:—

As President—Dr. J. Tatham.

As Vice-Presidents—Messrs. Waller, Michael, Newton, and Ingpen. The other officers as before, and as Auditor on behalf of the Council, Mr. J. M. Allen.

The members having been asked to propose those whom they desired to fill four vacancies on the Council, the following nominations were made:—

The Hon. Sir Ford North, proposed by Mr. Nelson, seconded by Mr. Vezey.

Mr. Western, proposed by Mr. West, seconded by Mr. Macer.

Mr. Scourfield, proposed by Mr. Bird, seconded by Mr. Bryce.

Mr. J. W. Reid, proposed by Mr. Hilton, seconded by Mr. Lloyd.

On the motion of Mr. Harris, seconded by Mr. Swift, Mr. Chapman was proposed and duly elected Auditor on behalf of the members.

Mr. F. W. Watson Baker exhibited a new spring cover-glass clip, devised by Mr. Pakes, of Guy's Hospital, for use in the examination of thin films of blood. He also exhibited an improved form of light filter suggested by Mr. Gifford.

The President said it gave a very beautiful light, and any one who worked with it would find it very comfortable as well as very efficient.

Mr. Baker in reply to Mr. Hardy said he had not tested this light photographically.

Mr. Karop, referring to the spring cover-glass clip, said that the examination of these films of blood was a matter of great

interest at the present time, because of the discovery of certain parasitic bodies in the blood of persons suffering from various fevers of malarial type, and with which they were, no doubt, in intimate connection as the cause or the carriers of the infection. The older method of examination was by puncturing the sterilised skin, say of the lobe of the ear, through a drop of solution, *e.g.*, osmic acid in normal saline, to dilute the blood and fix the corpuscles. Now it appeared preferable to use excessively thin films, which were rapidly dried and stained if necessary.

Mr. Swift exhibited a *binocular* microscope of aluminium, which had been made to the order of a lady; it had a mechanical stage, achromatic condenser, and two eyepieces, all mounted in aluminium. The aluminium microscope exhibited a short time since was a monocular; this one he believed to be the first binocular ever made in that metal.

The President said if what was wanted was a portable binocular, then this supplied the want to perfection, for he had never seen a microscope, possessing so many parts as this, which was so remarkably light. It was very beautifully made and finished.

Mr. Karop asked how the polished parts could be kept bright.

Mr. Swift said it was only necessary to rub them with a chamois leather; the metal itself did not tarnish easily, and no lacquer was needed to protect it from the air.

Mr. Karop said the introduction of microscopes of this kind would certainly effect a great revolution as compared with the times when the great heavy microscopes of Ross and others used to be brought down to the Club at a conversazione with so much labour and inconvenience. He believed that improvements in the manufacturing process had resulted in the production of metal of greater purity than formerly, rendering it much more easily workable.

Mr. Swift said it was much more difficult to work than most metals, but was much easier now than at the time it was first introduced.

Mr. Earland read a paper by Mr. Bryce Scott "On a method of preparing type slides of Foraminifera."

On the motion of the President, the thanks of the Club were unanimously voted to Mr. Earland and Mr. Scott for the paper, and for sending down the slides for exhibition in illustration of the paper.

Mr. Scourfield read a paper on "The Winter Egg of a rare Water Flea," illustrated by diagrams and drawings on the board.

The President said this was a paper more for the laboratory at home than for them to discuss at the meeting. It was a paper on morphology worked out with admirable detail, and one which did Mr. Scourfield a great deal of credit.

Mr. Karop inquired if it was always the case that the deposition of the ephippial egg involved the death of the female.

Mr. Scourfield said this was not so—it was the moulted part of the shell which was destroyed.

Mr. Hardy said his experience was rather the other way. He asked if Mr. Scourfield had ever hatched out these winter eggs to see if there was any difference between the winter and the summer eggs when hatched out. He had always thought the eggs were deposited at the bottom of the pond to hatch out in the natural way, the parent dying.

Mr. Scourfield said it was quite true in some cases that the animal had great difficulty in getting away from the winter egg with the old shell attached to it. In the majority of cases, however, the animal did get away. Many of the common Daphnias went right through the winter and started again in the spring. He collected the specimen in Barton Broad in September. He had intended to hatch out these eggs, but had never seen them actually coming out. As far as was known the animal hatched out exactly the same in every respect as from the summer eggs.

Mr. Bryce inquired whether if the egg were kept for several months any difference could be seen which would indicate the process of development?

Mr. Scourfield said the case was so dark that it was practically impossible to follow the changes. The egg rested for months until favourable conditions for development occurred; the difficulty of observation arose from the dark colour of the envelope itself, and not from a darkened colour due to segmentation of the egg.

The thanks of the Club were voted to Mr. Scourfield for his interesting communication.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

Annual Meeting.—February 17th, 1899.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. Henry Evans, Mr. Henry William Fairholme, Mr. R. T. Günther, Rev. Charles M. Gibbens, Mr. Edward John Hill, Mr. Sidney Leaning, and Mr. Arthur Powell.

The following donations, etc., were announced:—

"The Botanical Gazette"	In exchange.
"Journal of Applied Microscopy"	"
"Transactions of the Natural History Society of Glasgow"	From the Society.
"Report of the Illinois Laboratory of Natural History"	" " "
"Annals and Magazine of Natural History"	Purchased.

The Secretary said that the members would be pleased to hear that Mr. Lewis Wright had promised to give them an exhibition with the lantern microscope at their next ordinary meeting, on March 17th.

The business of the Annual Meeting was then proceeded with.

The President having appointed Mr. C. L. Curtiss and Mr. West as scrutineers, they proceeded to take the ballot for officers and for four members of Committee, subsequently reporting that all had been duly elected, as follows:—

President	John Tatham, M.A., M.D., F.R.M.S.
Four Vice-Presidents	J. G. Waller, F.S.A. A. D. Michael, F.L.S., F.R.M.S. E. T. Newton, F.R.S. J. E. Ingpen, F.R.M.S.
Treasurer	J. J. Vezey F.R.M.S.
Secretary	G. C. Karop, M.R.C.S., F.R.M.S.
Foreign Secretary ...	C. Rousselet, F.R.M.S.
Reporter	R. T. Lewis, F.R.M.S.
Librarian	Alpheus Smith.
Curator	E. T. Browne, B.A., F.R.M.S.
Editor	E. M. Nelson, F.R.M.S.
Four Members of Committee	The Hon. Sir Ford North, F.R.M.S. G. Western, F.R.M.S. D. J. Scourfield. J. W. Reed.

Mr. G. C. Karop, Secretary, then read the thirty-third Annual Report of the Club.

Mr. J. J. Vezey, Treasurer, read his annual financial statement and duly audited balance-sheet.

Mr. J. W. Reed said he had much pleasure in proposing "that the Report of the Committee and also the Treasurer's balance-sheet be received and adopted, and that they be printed and circulated as usual." He felt sure the satisfactory character of both would be apparent to all the members, and would need no further remarks from him to recommend this resolution.

Mr. B. W. Priest having seconded the motion, it was put to the meeting by the President and unanimously carried.

The President then read the Annual Address.

Mr. A. D. Michael said he rose to move that their best thanks be given to the President for the Address to which they had just had the pleasure of listening, and that he be asked to allow it to be printed in the Journal. He noticed with much interest that the President said he was going to return to the old custom of making the Annual Address an epitome of the work which had been done during the year, this being how he had himself on several occasions commenced his own Presidential addresses, immediately afterwards to enter into subjects which had nothing whatever to do with it. So when he found that the President had no sooner made this announcement than he proceeded to give them the results of his personal experience on matters of illumination, he felt that he had before him a very apt pupil. But whether this Address was to be regarded as a summary of the year's progress in microscopy, or as a piece of very practical advice based upon personal experiences, which would be of value to all, he was quite sure that they would join in giving a very hearty vote of thanks to the President for what they had been hearing.

Mr. C. West had much pleasure in seconding this motion, and felt it was unnecessary to add anything to what Mr. Michael had said, after the manner in which his remarks had been received.

Mr. Michael said this was a vote which the President could not put to the meeting himself; he therefore asked them to signify their approval, and declared it to be carried unanimously.

The President expressed his thanks to the members of the Club for this vote of thanks so kindly and courteously proposed and so cordially carried.

A vote of thanks to the Auditors and Scrutineers was then moved by Mr. A. Earland, seconded by Mr. G. T. Harris, and unanimously carried.

Mr. H. Groves said he had very great pleasure in moving that a very cordial vote of thanks be given to the Officers who had so ably conducted the business of the Club during the past year; and he should like to say from the body of the room how very much the services of the Officers and Committee were appreciated by the members, making special reference to the Treasurer, Secretaries, Reporter, Librarian, Curator, and the Editor of the Journal.

Mr. A. T. Spriggs having seconded the motion,—

The President said that this vote of thanks was one which met with his most cordial approval, because he, perhaps more than any member of the Club, felt grateful to the Officers, not merely for the general work they had done, but for the assistance they had given to himself personally. He had great pleasure, therefore, in commending this proposal to their acceptance, and asked them to carry it with acclamation.

Mr. Karop, in responding to this vote of thanks, expressed, on behalf of himself and his colleagues, the satisfaction which they felt at this mark of appreciation, although he thought that Mr. Nelson or Mr. Vezey should have acknowledged the vote—but, as they all knew, these gentlemen were so very shy. He thought, however, that they must be tired of seeing him in the same place year after year; if this was so, he hoped they would not hesitate to let him know.

Mr. Vezey said Mr. Karop had mentioned his most prominent characteristic—bashfulness: indeed, the only time he felt bold was when he wanted subscriptions. He was glad to find the funds in so healthy a condition. He would not have spoken again, but he wanted to point out how much they were indebted to Mr. Rousselet for the great increase in their receipts from advertisements in the Journal, the whole of which Mr. Rousselet had obtained for them, to an amount equal to forty-three new members. He also wished to acknowledge the assistance which he had received from Mr. Woodley, who was always ready to act for him when, from any cause, he was prevented from being at any of the meetings.

Objects Exhibited with Notes.

January 6th, 1899.

Mr. A. W. Dennis: Specimens of *Leocarpus vernicosus* found at Hinx Hill, Kent.

Mr. A. E. Hilton: The sporangia of *Arcyria punicea*, showing the capillitium after the dispersion of the spores.

Mr. H. Morland: The frustule and valves of *Navicula rœana* (Cleve) found by Mr. A. Durrand, a member of the Club, in the Island of Riyo, near Singapore. This diatom was originally named *Scoliopleura contorta*, Kitton MS., then *Pinnularia rœana* Castr. (*Challenger* Reports), and lastly *Navicula rœana*, Cleve.

Mr. A. Earland: A type-slide showing sixty species of the genus *Lagena*.

Mr. G. T. Harris: A preparation of *Hydra vulgaris* showing the ovaries and testes, stained with Mayer's Para-carmine. The specimen, with the generative organs well developed, was found in an aquarium in December last.

Mr. B. W. Priest: A colony of *Anguinaria spatula*, attached to seaweed from Australia. This same Polyzoon occurs on the British coasts, generally found on Fucus, but it is much smaller in size.

Mr. J. Holder: The statoblasts of *Lophopus crystallinus*.

January 20th, 1899.

Mr. A. Earland: A new and undescribed form of *Lagena* from the Miocene of Mt. Martha, Melbourne, Australia. Characteristic features: Basal half roughly covered with minute prickles; oral half glassy, with fine longitudinal striæ. Ento-ecto-solenian. The nearest relative is *Lagena ampulla-distoma* of Rymer Jones, which is covered, more or less, uniformly all over with a similar rough surface.

Mr. G. T. Harris: A preparation of *Nais lacustris* (= *Stylaria proboscidea*) showing a young form just budded off from its

parent by transverse fission, with the prostomium not fully developed from the clitellum. The specimen was killed and fixed with Lang's Fluid, stained with Para-carmine, and mounted in Balsam.

FEBRUARY 3RD, 1899.

Mr. H. Morland: A silvered slide of *Amphipleura pellucida*. The diatom was resolved by means of a vertical illuminator and a Leitz's $\frac{1}{10}$th Oil Immersion objective.

Mr. A. W. Dennis: Specimens of *Cribraria argillacea* taken from a fir stump near Stonehenge.

Mr. A. E. Hilton: The nymph of *Tegeocranus latus*, mounted in glycerine. The specimen was found on decaying bark at Golder's Hill, Hampstead.

Messrs. Swift & Son: A Möller's Diatom Test-plate on a photographic base in Mono-bromide of Naphthaline.

NOTICES OF RECENT BOOKS.

Photo-micrography. By Edmund J. Spitta, L.R.C.P., etc. Demy 4to, with 41 half-tone reproductions, and 60 figures in text. London: The Scientific Press, Ltd. Price 12*s*.

This is probably the most elaborate work yet published on the subject, which is yearly gaining favour as a means of book illustration, and indeed bids fair to drive the wood block almost entirely from the field it once held supreme—a fact, we confess, we are old-fashioned enough to regret. The subject-matter is treated throughout in such a manner as to give the intending photo-micrographer the utmost service a *book* is capable of affording; it will not make him a master of the art by mere perusal, but it will show the practice of an expert, and by adopting the author's methods to begin with the beginner may avoid some natural errors, and finally, as most workers seem to do, he will originate a procedure of his own. Mr. Spitta's book covers the whole ground, from magnifications of $1\frac{1}{2}$ to 3,000 diameters, and the half-tone reproductions by Dent & Co. show extremely well the advantages and, may we say, the disadvantages of this form of black-and-white process work.

The Science of Life. By J. Arthur Thomson, M.A. London Blackie & Son. Price 2*s*. 6*d*.

This is an outline sketch of the history of Biology and its main advances during, approximately, the period covered by the present reign. It consists of sixteen chapters dealing with the origin, development, and present position of classification, morphology, physiology, and embryology of plants and animals, the cell and evolution theories, and other biological problems; and although the treatment of each is necessarily brief it is most clear, luminous, and to the point. Altogether the book is an excellent digest of a very fascinating subject, and should be read by every member.

THIRTY-THIRD ANNUAL REPORT.

Your Committee is again in a position to give a satisfactory Report of the affairs of the Club during the past twelve months. Its general efficiency has been well maintained on the lines which have hitherto shown themselves best suited to the requirements of its members; and in regard to numbers, attendance at the meetings, quality of work, and financial soundness, the period covered by the present Report will bear comparison with any of its predecessors.

Thirty-four members were elected, and seventeen lost by resignation or removal and four by death—viz., Mr. Henry Perigal, F.R.A.S.; Mr. C. N. Peal, F.L.S.; Mr. Latimer Clark, F.R.S.; and Mr. H. B. Chamberlin. The total membership up to the end of the year 1898 was 328.

The average attendance at the meetings has continued to be most satisfactory, being for the nine ordinary sixty-eight, and for the fifteen conversational thirty-four. This is sufficient testimony to the interest taken in the proceedings.

The papers and other communications have also been extremely good, as well as fairly numerous. The following is a list of the chief:—

Jan.	On some little-known Pterodina ...	Mr. Rousselet.
,,	On the generative organs of *Drepanidotænia venusta*	Mr. Rosseter.
Feb.	Presidential Address	Mr. Waller.
Mar.	On the Æcidium stage of *Uromyces pisi*, etc.	Mr. Reed.
Apr.	On new Rotifers	Mr. Lord.
May.	On Diatom Structure	Mr. Nelson.
June.	On *Orbiculina adunca* and varieties ...	Mr. Earland.
Oct.	On the life-history of certain Fungi ...	Mr. Massee.
Nov.	On Marine Vegetable Organisms invading Calcareous remains	Mr. Harris.
Dec.	On a new Projection Microscope ...	Mr. Schroeder.
,,	On Structure of Nodules in Pleurosigma, etc.	Mr. Nelson.

Your Committee desires to put on record its obligation to the authors of these papers, several of which must have necessitated much expenditure of time and labour, as well as skill, for their production. The prestige of the Club outside its own walls is very largely dependent on the quality of its printed matter, and the Committee will welcome and do all in its power to assist members submitting their investigations to the meetings.

A rather marked falling off has been noticeable of late in the number of new instruments and accessories exhibited, which is probably due to the present appliances fulfilling most of the needs of microscopists rather than to want of invention. A very laudable endeavour to improve and reduce the cost of the 'student' class of microscope and its objectives appears to be the chief aim amongst opticians at the present time.

With a view of making the work of the Club better known, the Committee has had cards printed on which to announce the papers and other matters to be submitted at the meetings. Several well-known opticians have most kindly undertaken to display these notices in some prominent position in their places of business; and the thanks of the Club are due and hereby offered to these firms for this permission, which, it may be hoped, will answer the purpose intended. At the same time, it should be pointed out that, to be of value, the announcement must appear at least a week in advance of the meeting, and members are therefore requested to give the Secretary timely notice of their proposed communications.

The following is a list of the books and periodicals added to the Library during the year:—

"Cross & Cole's Modern Microscopy" ...	Presented.
"British Moss Flora," Part XVIII. ...	Dr. Braithwaite.
"Report of the Smithsonian Institute," 1895	U.S. Government.
"Tailless Batrachians of Europe," Vol. II., by Subscription...	Ray Society.
"Quarterly Journal of Microscopical Science"	Purchased.
"Annals and Magazine of Natural History"	,,
"Catalogue Générale des Diatomées" ...	,,
"Journal Royal Microscopical Society" ...	In exchange.
"Proceedings of the Royal Society" ...	,, ,,

"Le Diatomiste"	In exchange.
"La Nuova Notarisia"	,, ,,
"American Monthly Microscopical Journal"	,, ,,
"Journal of Applied Microscopy"	,, ,,
"Botanical Gazette"	,, ,,
"Proceedings of various Societies" ...	,, ,,

With regard to the Cabinet, the only noteworthy addition has been the valuable gift of a hundred slides of diatoms, mounted by Professor Hamilton Smith, from Mr. E. M. Nelson, to whom the Club is indebted for many similar donations.

As promised in the last Report, a list of the Tatem Collection of Insects has been prepared by Mr. C. Turner; but, after careful consideration, the Committee decided not to have this printed, as it is almost impossible to verify the nomenclature, and unless the specimens are correctly named their value is too small to justify any great outlay upon them. A vote of thanks is due to Mr. Turner for the considerable trouble he has been put to in making this manuscript catalogue.

The usual two numbers of the Journal have been issued, and an improvement will be noticed in the paper and letterpress; yet the total cost has been reduced by about £15. On the other hand, the receipts for advertisements are nearly £8 in excess of last year's; but, of course, both these amounts are liable to fluctuation. Until lately it was the custom to insert lists of the objects exhibited at the meetings, but these, being mere names, were without further value, and it was thought advisable to omit them. There will be no objection to recontinuing these lists, provided some short explanatory notes referring to the points of interest accompany the specimens; and new exhibition slips have been printed for the purpose.

As a result of the differences above mentioned, and also owing to the fact that there has not been the outlay on a Conversazione to provide for, the finances show a balance of about £40 in excess of that with which the year was begun. It must not, however, be lost sight of that our present membership is only just sufficient to furnish the ordinary annual expenses of the Club, notwithstanding the careful manner in which these are looked after and controlled by the Treasurer.

The Committee desires to cordially acknowledge the efficient

services rendered by the several Officers, to which the success of the Club is so largely due.

Finally, considering the manifest enthusiasm with which the past year's proceedings were conducted, your Committee cannot doubt a continuance of the Club's prosperity; but no sense of confidence in the future should be allowed to interfere with the effort of sustaining and furthering its interests, which, in some degree, is in the power of every individual member to contribute.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB.

For the year ending December 31st, 1898.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1897	158	16	7	By Rent of Rooms and Bookcases	54	12	0
,, Subscriptions received in 1898	160	0	6	,, Expenses of Journal...	92	14	4
,, Dividends on Investments	6	10	8	,, Postage	5	18	7
,, Sales of Journal	21	2	1	,, Printing and Stationery	4	14	1
,, Sales of Reprints	2	2	2	,, Attendance	6	0	0
,, Sales of Catalogues	0	7	0	,, Books, etc., purchased	5	7	3
,, Receipts for Advertisements	21	15	6	,, Petty Expenses	2	8	5
				,, Balance in hand	198	19	10
	£370	14	6		£370	14	6

INVESTMENTS.

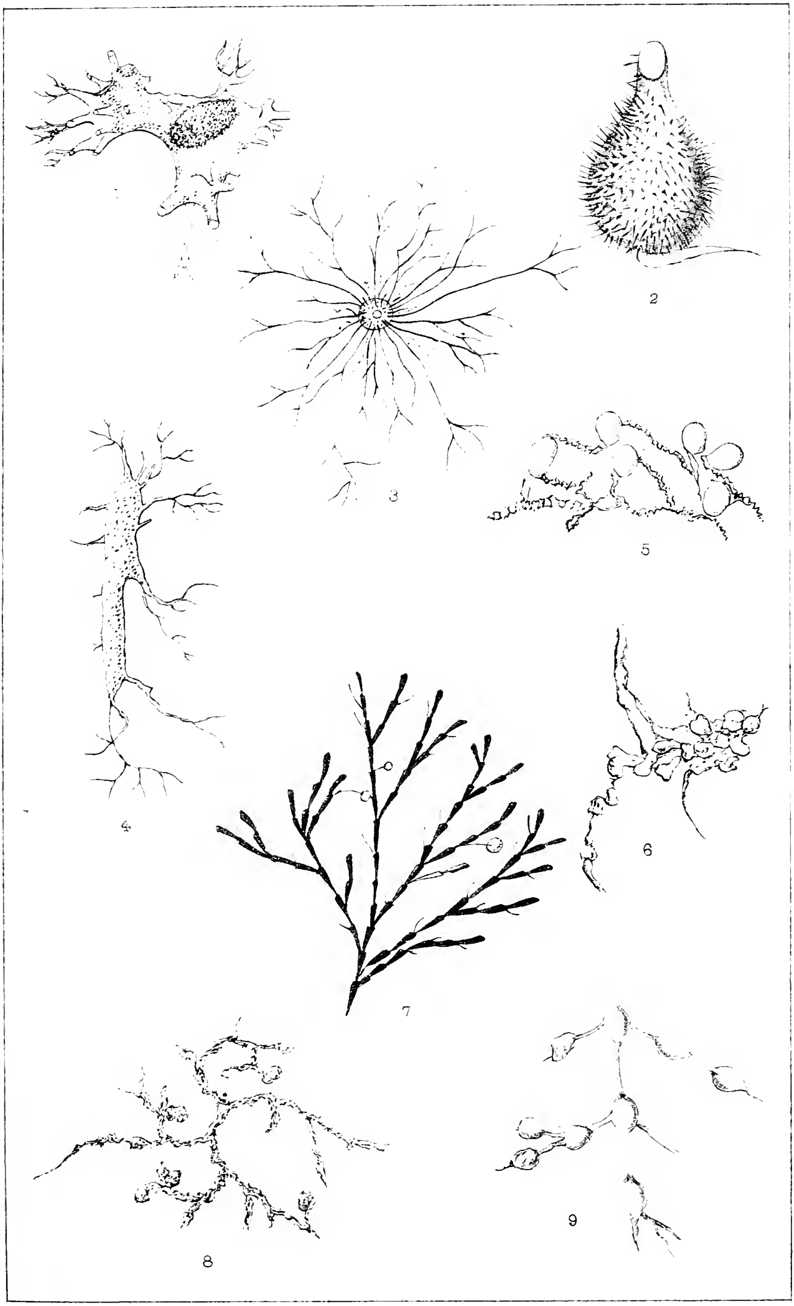
	£	s.	d.
Moneys Invested in £2 15s. Consols	200	0	0
,, ,, ,, £2 10s. Metropolitan Stock...	49	5	0
	£249	5	0

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and find the same correct,

January 27th, 1899.

J. J. VEZEY, *Hon. Treasurer.*

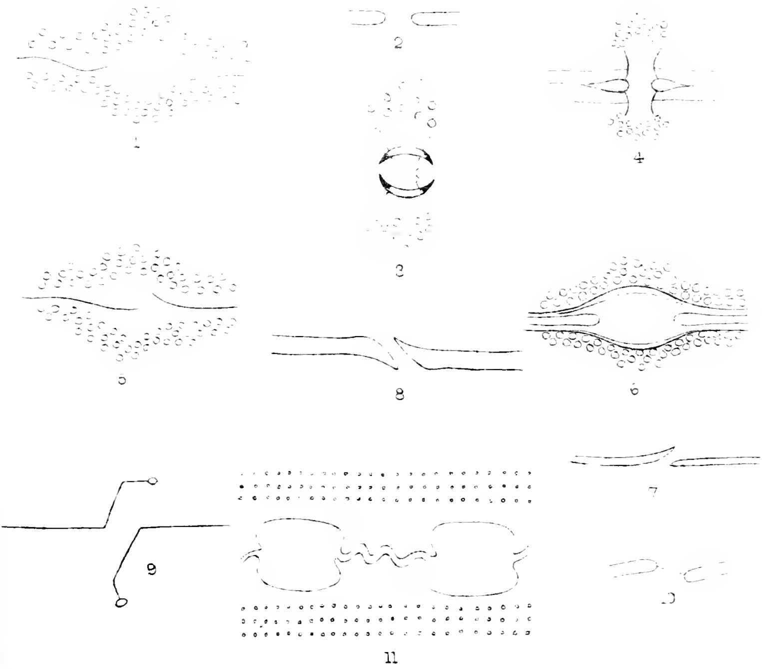
W. INGRAM CHAPMAN,
J. MASON ALLEN, } *Auditors.*



J. G Waller & W.H.Harris del.

West Newman

J G Waller & W H Harman del.



D.M.M.Nelson del. West Newman lith.

D. J. Scourfield del. West Newman lith.

Leydigia acanthocercoides.

Atax Taverneri sp. nov. ?

By C. D. Soar, F.R.M.S.

(*Read March 17th*, 1899.)

Plate 12.

At the beginning of August last year Mr. Henry Taverner, a member of the Club, while collecting in Highams Park, took a number of specimens of a species of *Atax*, which he kindly handed to me for examination. It proved to be one I had not before met with.

To the best of my belief I have descriptions and figures of all the known species of this genus, about thirty-four in all if we include the sub-genus Cochleophorus Piersig., in which some of these have now been placed, but with none of these will the mite submitted to your notice this evening quite agree. It may resemble some in the palpi, but differs in the genital area; or it may agree with others in the genital plates but be different in the palpi. The nearest relation I can find to it is *Atax aculeatus* Koenike. The general description given of this mite in the "Zoologischer Anzeiger" agrees very well with mine, except in two very important points: viz., *A. aculeatus* has three discs on the upper plate of the female, and it is parasitic in the fresh-water mussel, in the same way as *A. ypsilophorus* Bonz., whereas the present one has only two discs on the upper plate of the female, and it is a free swimmer in the same way as *Atax crassipes* Müller. This being the case, I have very good reasons for believing it to be a hitherto unrecorded species.

Dimensions :—

	♀	♂
Length about	1·12 mm.	0·96 mm.
Breadth ,,	0·78 ,,	0·76 ,,
1st leg	1·44 ,,	1·24 ,,
2nd leg	1·80 ,,	1·50 ,,
3rd leg	1·40 ,,	1·18 ,,
4th leg	1·88 ,,	1·44 ,,
Palpi	0·48 ,,	0·43 ,,

Colour :—

A pale straw-yellow with darker markings on the dorsal surface, very much the same as some species of *Atax crassipes* Müller.

Form :—

A long oval truncated at the posterior margin, very much the same as *A. crassipes*, for which, at first sight, it may easily be mistaken, as, like this species, it has the two papillæ, one at each angle of the posterior margin. In this respect it also agrees with *Atax aculeatus* Koenike. These two papillæ project beyond the body line, in some specimens more than others, and they are common to both sexes.

Legs :—

Do not essentially differ from those of *A. crassipes*, except that they are not so long in proportion to the length of body. The first pair possess those powerful bristles or sword-hairs peculiar to the members of this genus, and the second pair are much longer than the first.

Palpi :—

Resemble those of *A. figuralis* Koch., except that on the third segment Piersig has drawn a pectinated hair, which is absent in the mite now before us, its place being taken by one which is quite simple and sharp.

Genital area :—

In the female there are four plates similar to *Atax crassipes*, but the discs are different, there being but two in each upper plate and three on each of the lower. This arrangement is very general, *A. bonzi*, *A. figuralis*, and several others having ten discs placed in similar positions. In the centre of the four plates are two powerful spurs bent outwards, and outside the plates, one on each side, are the papillæ before mentioned. In the male there are only two plates with five discs on each, and in a similar position to the discs on the male plates of *A. bonzi Claparède* except that there is not so much space left on the plate itself at its upper part.

Locality :—

Found in clear water at Highams Park, free swimming; several specimens were taken and also a few nymphs.

I think the above is sufficient to distinguish this creature from other species of the same genus, and if my view is correct that

this is, as yet, an unrecorded species I propose to name it *Atax Taverneri*, in honour of the gentleman who found it.

Explanation of Plate 12.

Atax Taverneri.

Fig. 1.—Ventral surface of male, showing epimera and genital plates.

Fig. 2.—Genital plates of female seen from the ventral surface.

Fig. 3.—Right-hand spur in centre of female genital plates.

Fig. 4.—Genital plates of male.

Fig. 5.—Palpi of male inside surface of right-hand palpi.

Fig. 6.—Claws of first leg.

Fig. 7.—Claws of fourth leg.

Notes on some Australian Ticks received from Mr. C. J. Pound, F.R.M.S.

Communicated by R. T. Lewis, F.R.M.S.

(*Read April 21st*, 1899.)

Plate 13.

Many of the members of the Club now present will very well remember Mr. C. J. Pound who joined us in 1890, and during his residence in England was a regular attendant at our meetings, and an occasional contributor to our proceedings. He was at that time connected with the Bacteriological Laboratory at King's College, but being subsequently appointed by the Queensland Government, Director of the Brisbane Stock Institute, he went out to the Colony, and has since been actively employed in scientific investigations with a view to ascertain the causes and possible remedies against the diseases of cattle and live stock which were at the time entailing such serious losses to the owners as to call for the attention and assistance of the Colonial department of Agriculture.

Mr. Pound has not forgotten his old friends, but has occasionally made communications to the Club through Mr. Vezey; and in one of these, which was read to us last year, Mr. Pound mentioned that his attention had been for some time engaged in studying the mischief due to the attacks of Cattle Ticks, which it seemed must be held responsible for much more than the perforation of hides and the sucking of blood—the bites introducing disease germs previously acquired by the ticks from infected sources, and giving rise to inflammatory sores, the effect of which upon the animal was to set up conditions of disease known as tick fever, red water, etc., which in many cases proved fatal.

The process of examining the animals and pulling off the adherent ticks was not only tedious and difficult to carry out thoroughly, but it for the most part greatly aggravated the

trouble, inasmuch as the hold of the tick was usually so tenacious that rather than let go it allowed itself to be torn away, leaving its barbed rostrum imbedded in the flesh, and by its presence producing a festering centre which in combination with many others contributed towards the general blood-poisoning. The safer methods of clearing the cattle from ticks by the application of a wash which by obstructing their breathing pores caused them to drop off by themselves to avoid suffocation, was not effective as against the feverish symptoms which supervened in consequence of bites already inflicted. Attention was therefore directed towards the possibilities of counteracting the disease by the injection of some suitable anti-toxin.

So far as reports to hand go, this process of inoculation has been attended with excellent results.

It has been part of Mr. Pound's work to spread in all available ways correct information as to the life-history and habits of ticks, the mischief they are capable of doing, and the best methods of dealing with or preventing it, and this has been done both through the press and by means of illustrated lectures. I have here a copy of one of Mr. Pound's diagrams illustrating the life-history of the cattle ticks, cut from the columns of the *Queensland Grazier* of August 19th, 1898, where it appeared as part of a reprint of an article from his pen appearing some time previously in the official publication *The Agricultural Journal*. In this article Mr. Pound gives the following account of the life-history and development.

"Larval ticks are capable of living, in some instances, for a period of over four months without food or moisture, apart from their host.

"These young ticks attach themselves to their host singly, and not in pairs or clusters.

"Up till six days their growth is scarcely noticeable, but on the seventh day they undergo a change and throw off their skin, and are then seen with an extra pair of legs.

"From the seventh to the fourteenth day they grow but very little, and on the latter date they undergo a second change, which determines the sex. If the change should result in a female, she still remains attached in the same place; but if it should result in a male, he immediately releases his hold and wanders about amongst the hair of the animal until he finds a female,

with which he mates, attaching himself to the animal just beneath the female.

"The pair will remain attached to their host until the twentieth day, increasing in size but very slightly, the female being a little larger than the male. From the sixteenth to the twentieth day the male fecundates the female.

"On the twenty-first day the female becomes fully mature, releases her hold, and falls to the ground; then crawls to some secluded spot and lays her eggs, which in course of time (from three to nine weeks) will hatch, and then the life-cycle commences again.

"After the departure of the female, the male tick sometimes remains for several hours, when he becomes detached, falls to the ground, and rarely lives longer than two or three days."

It is of course not possible to make comparisons between observations made upon ticks in this country and those under natural conditions in the warm countries where they are indigenous. Brisbane is in latitude 27°·28′, or within four degrees of the Tropic of Capricorn, whilst all the northern portion of the Colony is intertropical. The specimens of ticks which have been sent to me from various localities in Africa and China have generally arrived in this country during our winter season, the one exception being a yellow tick from a horse in Natal which reached me early in June. I was fortunate in seeing this tick lay its eggs, and in hatching the eggs so laid, and found that those laid on June 6th hatched out on July 14th, or in about six weeks, kept warm meanwhile by being carried constantly in the pocket. The larvæ lived from two to three months without sustenance, although every opportunity was afforded them, and they certainly underwent no change. I have also on many other occasions hatched the eggs of cattle ticks from South Africa and China, but always failed to develop them further, though the larvæ on one occasion survived nearly six months. It is also a matter of some surprise to learn from Mr. Pound's description that the complete development is reached in twenty-one days, that the fourth pair of legs appear at the first moult when seven days old, and that the pairing of the sexes takes place so long before either individual has reached its mature stage.

In the course of last year Mr. Pound mentioned in a letter which Mr. Vezey read at one of our meetings, that he hoped

shortly to send over some specimens of the ticks which were abundant in Queensland; and in December last a packet arrived containing ten small bottles in which were a large number of ticks of different species preserved in a 3-per-cent. solution of formalin. The labels on the bottles indicated the localities from which these ticks came, and the animals on which they were found, but none of the species were named. The very cursory examination which I have as yet been able to give them shows them to be well preserved from decomposition, but so far as I can see them through the bottles, I fear very few of the cattle ticks are sufficiently perfect to make good specimens for a collection, the majority apparently having been pulled off the animals to which they were attached, with the usual result that the barbed rostrum has been broken off and left behind. Briefly enumerated, the contents of the bottles are as follows:—

No. 1.—"Larval Cattle Ticks." These apparently differ in no way from those which I have frequently hatched out, and have on several occasions exhibited alive in this room.

No. 2 is labelled "Cattle Ticks Mixed." This bottle I have here, and those who examine it will doubtless agree that the description "mixed" is perfectly correct.

No. 3.—"Male Cattle Ticks." About six specimens, of about the size of those shown in Mr. Pound's diagram.

No. 4.—"Cattle Ticks in Various Stages." Five or six different species.

Nos. 5 and 6.—"Male and Female Dog Ticks." These differ from the common European dog tick *Ixodes Ricinus.*

Nos. 7, 8, and 9.—Contain specimens of cattle ticks from Java, South America, and New Guinea respectively.

No. 10 is labelled "Queensland Fowl Ticks."

In the letter which accompanied this consignment, Mr. Pound gives some further particulars which are of interest as the result of his personal observations. He tells us that the "Cattle Ticks" are those which are the cause of the dreaded tick fever in cattle, but although these creatures will often attach themselves to, and even mature on other animals, such as the horse, the sheep, and the kangaroo, their bites never set up fever in either; they have never been found attached to dogs, and the females are far more numerous and larger than the males. The species which infest dogs, both the native dingoes and the imported domestic

dogs, although very numerous, do not seem to cause much inconvenience to the animals; the males of these are said to largely predominate, and to be larger than the females; these are especially common in the tropical districts of North Queensland. Mr. Pound also mentions as a peculiarity of what he calls the "true cattle ticks" that they are at once distinguished from all other kinds in having white and semi-transparent legs, whereas the others have either red or dark brown legs. This must be a peculiarity of the Queensland variety, as I have about ten different species of cattle ticks from Natal and Cape Colony, the legs of which are either red, or brown, or banded with these colours. Perhaps I should not omit to mention that Mr. Pound speaks of having made lantern slides from the plates in illustration of the paper "on the process of oviposition in the cattle tick," by a member of this Club; it is well that our members should know that their papers read in this room very often have a wider field of usefulness than they have any idea of, and whilst interesting and instructive to their friends here, may prove even still more practically useful on the other side of the world.

Personally, I may say I have been more interested in the contents of Mr. Pound's tenth bottle than in any or all of the others; for whilst they contain varieties of what appear to be *Ixodidæ*, No. 10, labelled "Queensland Fowl Ticks," undoubtedly contains the rarer *Argassidæ*. It curiously happened that three or four months ago I had a special request from Cape Town to procure, if possible, some specimens of *Argas reflexus*, a kind of tick said to be common in Europe, and to be frequently found in pigeon-houses, lying concealed in crevices during the day but attacking the birds whilst roosting at night. This creature, although well known in Europe, does not appear to have been described here until March 1871, when some specimens were discovered in a portion of Canterbury Cathedral then undergoing repairs. Two specimens subsequently found also in one of the passages of the Cathedral in April 1872, lived in a glass-topped box for one year and ten months; they laid eggs about two months after their capture, and the eggs hatched about six weeks later. the young had six legs, but though they lived about six months they did not develop further. On being submitted to Professor Westwood, they were by him determined to be *Argas reflexus* of *Latreille*, synonymous with *Ixodes Marginatus* of Fabricius, and

Rhynchoprion Columbæ of Herman, and possibly also with *Argas Fischeri* from Egypt, and *Argas Mauritianas*, or even with the poison bug of Persia, *Argas Persicus*. The "Canterbury Tick" was described and figured in "Science Gossip" for 1874, by Mr. James Fullagar of Canterbury; and I remember the late Mr. Thomas Curties calling attention to it and exhibiting a specimen at one of the meetings of the Club then held in the Library of University College.

My efforts to obtain specimens for my Cape correspondent were not attended with success. Owners of pigeons to whom I applied repudiated the idea that their birds harboured such vermin. Nor could I procure a mounted specimen from any dealer. An inquiry addressed to our member, Mr. Rossiter, only elicited the information that Mr. Fullagar had been dead some years and his collections dispersed. Further inquiries on the part of Mr. Rossiter led to the discovery of the official of the Cathedral who was the original finder, but this gentleman was only able to inform me that since the restoration of the places where the ticks were first met with, the creatures had entirely disappeared. Mr. Charles Curties had, however, a mounted specimen in his possession, of which he made a very excellent photograph, and this I sent to Cape Town as the best I could do in the matter. I had a reply by last week's mail to the effect that the writer had on careful comparison no doubt whatever that the Canterbury Tick was identical with the species which attacked fowls at night in the Colony. It often happens that we search far from home for what is close at hand; and so it proved in this instance, for whilst taking all this trouble to obtain a specimen of *Argas reflexus* elsewhere, a dozen were all the time upon my own table in Mr. Pound's bottle labelled "Queensland Fowl Ticks."

I hope to be able to mount some not only of these but of each other kind of tick forwarded by Mr. Pound, and to bring up a set, when ready, for the Cabinet of the Club. Up to the present time, however, I have been unable to secure the needful leisure for the purpose.

Since writing the foregoing I have been favoured by Mr. C. L. Curties with the loan of two slides of the original "Canterbury Ticks" found by Mr. Fullagar, and mounted in Canada balsam by Amos Topping. The most careful comparison shows these to be identical in every respect with those sent from Brisbane by

Mr. Pound; but inasmuch as Mr. Fullagar's drawing does not very accurately represent this tick it has been thought desirable to illustrate the present paper by figures enlarged from Mr. Pound's specimens. Those who have the article in "Science Gossip" to refer to will notice that the fig. 26 on p. 122 of vol. x. shows the palpi as having three joints instead of four, and gives six joints to each leg, whereas the first pair of legs have seven joints, and the other three pairs have eight joints each, exclusive of the claws. The claws are also erroneously drawn as being in one solid piece with the terminal joint of the tarsus.

Explanation of Plate 13.

Fig. 1.—*Argas reflexus*, dorsal aspect, from a specimen mounted in Canada Balsam. × $8\frac{1}{2}$.

Fig. 2.—*Argas reflexus*, ventral aspect, from a dry and unmounted specimen. × $8\frac{1}{2}$.

Fig. 3.—Mouth organs of *Argas reflexus*, ventral aspect, from a dry specimen. × 65.

Fig. 4.—Fore foot of *Argas reflexus*, from same specimen as fig. 1. × 65.

Early Memories of the Q.M.C.

By M. C. Cooke, M.A., LL.D.

(*Read June 16th*, 1899.)

The President and Committee and others have pleaded so earnestly with me to undertake, what I may call the domestic History of the Q.M.C., that at length I have determined to make an effort at satisfying their demands, although, I am bound to confess, with some reluctance, because I was so intimately associated with the conception and birth of the Club, that I am liable to a strong imputation of egotism in narrating the true, unvarnished tale. Allow me at the outset to repudiate any desire for self-glorification, and to affirm that I had much rather this duty had fallen upon some one of my coadjutors, if so many of them had not departed from the scene of their labours, and left me almost alone.

It might seem that, in some instances, I have introduced rather irrelevant matter; but I have judged it better to reproduce all the circumstances, in order to convey a clear understanding of all the subsidiary influences which combined to render the establishment of the Club one of the successes of the time.

Older members will recollect that in 1861, and in succeeding years, Mr. Robert Hardwicke was an earnest and successful publisher of Natural History books at his house in Piccadilly, where he was publishing the "Popular Science Review," with the help of Mr. Thomas Ketteringham as his manager. Later on he conceived and carried out the publication of the third edition of Sowerby's "English Botany," with Dr. Boswell Syme as Editor and Mrs. Edwin Lankester as responsible for the popular notes. Now, Dr. Edwin Lankester and his wife were at that time personal friends of Mr. Hardwicke, and, as such, were at least well known to myself, who made an almost daily visit to the little shop in Piccadilly. As contributor to the pages of the "Popular Science Review," and as a writer of popular books on Natural

History, of which Mr. Hardwicke was the publisher, I was in close business relations with Mr. Hardwicke, to whom I feel sure that I was, in the first instance, introduced and recommended by Dr. Lankester. At length I suggested to Mr. Hardwicke and to Mr. Ketteringham that there was a good opening for a cheap monthly magazine, which should be devoted to Natural History and Microscopy, offering facilities for exchanges and copious notes and queries. This idea was eagerly entertained, and "Hardwicke's Science Gossip" was the title suggested by Mr. Hardwicke, and to this he adhered pertinaciously. At length the scheme took form, and I was selected to model and afterwards act as Editor of the new Journal. The first number appeared January 1st, 1865, and became at once a success. At that time there was no competitor, and for a long time it was the only cheap Journal of Natural History.

Naturally, there was a very large number of patrons and contributors from the ranks of what we called at the time Amateur Microscopists, and there was always a long list of exchanges of microscopical objects, so that "Science Gossip" became the popular magazine of the microscopist. Probably if there had never been a "Hardwicke's Science Gossip" there would never have been a Q.M.C.

At this time Mr. Thomas Ketteringham had two hobbies which he pursued simultaneously; the one was his microscope, for which he was an enthusiast, and the other was his violin. To these he devoted the whole of his energies, when he had finished his daily labours in Piccadilly. I was not long in discovering that Ketteringham had a "chum" who was also microscopical and musical, and with whom he was accustomed to spend an occasional evening, primarily with the microscope. I was soon introduced to this congenial companion, whose name was W. M. Bywater, and who was the manager of a select business house in Hanover Square. Of course we became intimates, and it was a recognised institution that we three should meet about once a week, after eight o'clock, at Hanover Square, and go through a regular programme, which never varied. For an hour, or an hour and a half, in the counting-room at Hanover Square, we examined our objects of interest under the microscope, each bringing with him anything of special interest, which we discussed, and we discussed nothing else for the time being.

This was the model of a Q.M.C. gossip night with three members. At ten o'clock the microscopes were put away, and then we discussed sandwiches, cigars, and liquid refreshment, and many things besides, until eleven o'clock. Amongst other things to talk about was "Science Gossip," both before and after the first number, and doubtless these discussions had some influence upon the fate and the developments of the journal in question.

It was on the 1st of May, 1865, that a proposal from Mr. W. Gibson was published on page 116 of "Science Gossip" to the following effect:—"It appears to me that some association amongst the amateur microscopists of London is desirable, which shall afford greater facilities for the communication of ideas and the resolution of difficulties than the present Society affords, and which, whilst in no respect hostile to the latter, shall give amateurs the opportunity of assisting each other as members of an amateur society, with less pretensions; holding monthly meetings in some central locality, at an annual charge sufficient to cover the incidental expenses—say five shillings a year—on the plan of the Society of Amateur Botanists. By the publication of this letter the general feeling of the parties interested will be ascertained, and by this future action determined.—W. Gibson." To which the following editorial note was appended:—"N.B. We insert our correspondent's communication, and would be glad to hear from any microscopists desirous of co-operating with him in carrying out his proposition."—Ed. "Science Gossip."

Of course this letter occupied the attention of the trio at their next meeting, and all of us resolved to make a strong effort for the establishment of such a society as that proposed. One of the three was already a Fellow of the Microscopical Society, and there was never any feeling of antagonism amongst us to that Society, but, as we believed, a strong presumption that the new Society would benefit the old one, by helping the members over the early difficulties of the student, and fitting him better to appreciate the older Society.

The reasons which appealed to us most strongly at this time were, that there were a large number of young microscopists arising in the Metropolis, who could not afford to pay the subscription to the old Society, and, if they could do so, they would not get what they most required—that is to say, sympathy and

encouragement, as well as practical help and advice in their studies. Moreover, a society was required which either initiated or encouraged social field work, and was disposed to foster social intercourse and fraternisation. It was frankly acknowledged that at this time the old Society was too exclusive, and self-contained, to interest itself in students, and was incapable of training the rising generation of microscopists. The feeling of monopoly had to be broken down, and the coming Q.M.C. was fated to be the instrument.

When the proposal was formulated, Mr. Hardwicke was pleased with the idea, and although he was not a microscopist himself he volunteered to do all that he could to assist in its realisation, by placing his office at disposal for preliminary meetings, and allowing it to be used as a provisional office for correspondence. On July 1st, it was announced in "Science Gossip" that at a preliminary meeting, which was held on June 14th, at Mr. Hardwicke's office, it was decided to hold a general meeting for organisation at the St. Martin's National Schools, Charing Cross, on July 7th, for which purpose a provisional Committee had been appointed, consisting of the three persons already mentioned, with Mr. Hardwicke and his friend Mr. S. Highley, together with the originator of the proposal, Mr. W. Gibson.

The next important step taken was the organisation of the Quekett Microscopical Club on July 7th, 1865, with a Provisional Committee, and Mr. R. Hardwicke as Treasurer. At all these meetings, until the election of the President, the chairman was the writer of this notice, and the acting secretary, Mr. W. M. Bywater. Two subjects occupied most of the discussion at the July meeting—viz., the name of the Club, and the terms of subscription. Mr. Richard Beck took an animated part in the discussions, and greatly assisted the Committee by his sympathetic attitude, aided by his experience in practical microscopical work, and his appreciation of all efforts on behalf of struggling students. I am not sure my memory is accurate, but I think it was Mr. Beck who proposed the name of the "Quekett Microscopical Club," and that was ultimately unanimously adopted. It was urged that the word "Club" would better express its aims and objects than that of "Society." The other struggle was between those who advocated a subscription of five shillings and those who contended for a subscription of ten shillings per annum.

On both sides an entrance fee was repudiated, and the subscription fixed at ten shillings a year. The place of meeting was arranged as 32, Sackville Street, W., and these rooms were occupied until they became too small, and the Club migrated to University College.

The first and original members of the Club were twelve, who have since been, rather irreverently, styled the "Twelve Elders," and their names—

W. M. Bywater,	S. Highley,
M. C. Cooke,	E. Jaques,
W. Gibson,	T. Ketteringham,
E. R. Godley,	E. Marks,
H. F. Hailes,	W. W. Reeves,
R. Hardwicke,	G. W. Ruffle.

As far as I know, about half of this number, at the time of writing these notes, are deceased; two have dropped out of all knowledge, and did not remain long in connection with the Club, whilst four only remain to ruminate on the event with which they were associated thirty-four years ago.

When it was determined that the rooms in Sackville Street were too small to accommodate the growing Club, our Secretary was requested to make inquiries for more commodious quarters, and by some means he succeeded in securing a valuable ally in Dr. W. Sharpey, F.R.S., Professor of Anatomy and Physiology at University College, through whom he ultimately obtained permission of the College authorities to hold the meetings of the Club in the spacious Library of that institution; and this arrangement was maintained for many years, in fact until the end of 1889. At the beginning of this year, on the representation of the College librarian that the books in his charge were being seriously damaged by the gas used for lighting, the Council, with expressions of regret, felt itself compelled to withdraw the privilege accorded to this and one or two other kindred societies of holding their meetings in the Library. Another room, the Mathematical Theatre, was courteously placed at the disposal of the Club, but after some months' trial this was found so unsuitable and inconvenient in arrangement as to imperil its very existence. Hence it became imperative, once more, for the Club to change its quarters, and after some considerable trouble in finding

accommodation in accordance with its needs and means, it finally settled in its present home.

It will be conceded that, not only in the first instance, but through its entire career, the Club has been remarkably fortunate in its selection of Secretary. It would scarcely have been possible to have found a more thorough business man, of a more amiable disposition, prompt, punctual, methodical and unassuming, than its genial first Secretary, to whom the early success of the Club must be largely attributed.

Next in importance to the Secretary, the founders of the Club were impressed with the importance of securing the best possible first President, and this was for some time a matter of anxiety. It is very customary, in cases of this kind, to propose as a first President the person who has held the chair at all the preliminary and provisional meetings. Whether in accordance with custom, or otherwise, I was requested to allow myself to be nominated as President for the first year, but this I at once declined to do, in the event of the Committee being able to secure the services of Dr. Edwin Lankester, or some one of equal repute or influence, and this decision I have never regretted. I contended that a President who was already a Fellow of the Microscopical Society would bear evidence that the Club was *not* an opposition Society and that, with Dr. Lankester as President, the Club would at least be held in respect by kindred Societies, whereas I was myself a comparatively unknown man except within a limited circle, and I felt conscious that I was not possessed of that influence which was essential for the first President of a Club, so predestined to success as the Quekett Microscopical Club appeared to me to be, provided no false step were taken in the election of its officers. Fortunately, the friendship and influence of Mr. Hardwicke, added to my own request, secured the services of the man whom we all regarded as the best man, under all the circumstances, to preside over the Q.M.C. during the first year of its existence.

The bye-laws and regulations were drawn up by myself and Bywater, and afterwards considered and adopted by the members. I was requested also to draw up the prospectus or programme, which was endorsed by the conclave of three and afterwards officially adopted.

Thus the Q.M.C. was floated, with its officers and Committee,

holding its meetings on the fourth Friday in the month at the rooms in Sackville Street, with its offices, for some years, for letters and correspondence, at 192, Piccadilly.

Very little was seen afterwards of the proposer of the Club, Mr. W. Gibson, who attended a few meetings and then subsided into oblivion.

The social phase of the Club was realised in the "gossip" nights, in the fortnightly excursions, in the occasional *soirées*, and in the annual excursion and dinner at Leatherhead. During later years, with the abolition of dinners and *soirées*, much of the genial, social life of the Club has been lost.

As to the periodical excursions some little explanation may be necessary. For some years previous to 1865 there was in existence a small society, called the Society of Amateur Botanists, which I was chiefly instrumental in founding, and which met once a month for the reading of papers and discussions on botanical subjects, but which was chiefly characterised by fortnightly excursions into the country during the summer months, for collecting plants, and for a cosy tea afterwards. As far as I am aware, this was the only instance, at that period of time, in which any periodical excursions were made by any society in or around London. Of course, as the president and conductor of these excursions, I gained so much experience that I was able to initiate similar excursions for the Q.M.C., and thus they were organised in the first instance on the model of the excursions of the Society of Amateur Botanists. The members of the latter Society, or many of them, joined the Q.M.C., and always declared that the newer and larger Society with a wider programme had extinguished them. At any rate, such members as Mr. W. W. Reeves and Mr. Ruffle, who came from the Amateur Botanists to the Q.M.C., were distinguished for their help in organising similar excursions for the latter.

It is interesting to trace the evolution of one chain of events from another, as exemplified in this short history. In the later years of the fifties I conducted Botanical classes under the Science and Art Department, of which I was the first certified teacher under the Minutes. In order to give them a little practical demonstration, I sometimes took the pupils for country rambles in search of wild flowers. Subsequently some of these old pupils, who were joined by outsiders, constituted themselves into a little

society with a subscription of half a crown a year, the above-mentioned Society of Amateur Botanists. Afterwards their excursions became the model, and supplied some of the material, for the early excursions of the Q.M.C.

In like manner the constitution of the Society of Amateur Botanists, with its monthly meetings and its fortnightly excursions, its moderate subscription and its social habits, originated the idea in the mind of Mr. Gibson that a similar association was possible for microscopists.

Then again the issue of "Science Gossip" brought many microscopists into communication with each other; and a casual letter, which might have been a dead letter under different conditions, was the cause, within six months, of the organisation of the Quekett Microscopical Club, which at one period of its existence had a list, nominally at least, of about six hundred members.

Whether rightly or wrongly I will not pretend to affirm, but at least during the quarter of a century throughout which I was actively in connection with the Club, it was an understood principle, although it never appeared in writing, that no "maker of microscopes" should be elected to any office in connection with the Club. The reason for this decision will be apparent to any reflective person. It would have been invidious to have elected any "maker" to the exclusion of others, it would have introduced a trade element, which ought to be avoided, and would have raised suspicion of undue preference, which would have acted prejudicially to the interests of the Club. It was, I believe, Mr. Richard Beck who suggested this course to us, when he at first refused to take office on the original Committee; and personally I think he was perfectly right, although I hesitated a few minutes to record my opinion. Another of the "twelve elders," who was closely associated with the trading interest, was strongly opposed to the exclusion above alluded to, and consequently withdrew from all active co-operation in the progress of the Club. I am under the impression that this feeling on behalf of exclusion did not so much influence the members in the early days as it did afterwards; inasmuch as I find that both Mr. Beck and Mr. Highley did take their seats on the Committee for a year or two, the circumstances of which I have forgotten, but remember that it was accepted only as a temporary arrangement and was not afterwards repeated.

One is led into personal reminiscences in constructing this narrative, which need scarcely be repressed after so long an interval, and in view of the fact that the majority are no longer with us. One reflection, which is made patent by the above short history, is, that although the formal proposal came from an outsider, the practical inception and development of the idea of a popular microscopical Club rested with the little group of Piccadilly friends associated with the first Treasurer; and Messrs. Hardwicke, Ketteringham, Bywater, Cooke, and Ruffle were all, more or less, connected with the Piccadilly house, the last named being the engraver of the woodcuts which adorned the pages of "Science Gossip." Mr. Marks also acted at times as editor's substitute, or honorary editor, during my holidays or absence from town. Mr. S. Highley was a business friend or acquaintance of Mr. Hardwicke, and all who knew him will recognise how very microscopical was his influence, and operation, in the development of the new idea.

Two new and staunch adherents were acquired from outside sympathisers in the persons of Mr. H. F. Hailes and Mr. E. Jacques, and the constant presence of both at all the meetings of the Club for about a quarter of a century, until death removed the one, is too well known to the older members to need further allusion.

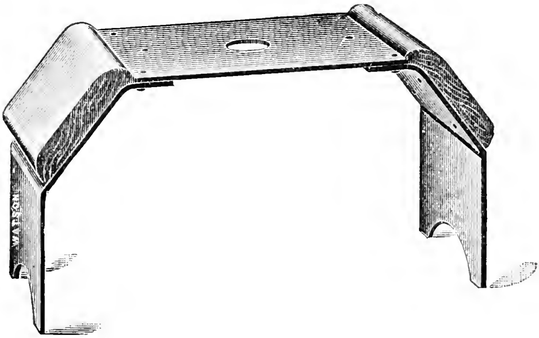
I cannot refrain from some notice of one most indefatigable member of the original twelve, who was not one of the Piccadilly brotherhood, although well known at the Piccadilly house, and a very active member of the little Society of Amateur Botanists. This was our old friend Mr. W. W. Reeves. His willing aid and advice in all the social functions of the Club, especially in the excursions, was always freely given and duly appreciated. In his own quiet way he was for many many years an earnest worker in the interest of the Club. Those who knew him intimately well remember with pleasure his quiet, genial manner, and the pertinacity with which he worked for the development of the social element of the Club, whether in connection with the periodical excursions, the little dinners, the gossip nights, or the long forgotten *soirées* at University College.

Perhaps I have written enough to indicate the surroundings and circumstances which combined in the origination of the Quekett Microscopical Club, with which I was as familiar as any

survivor amongst the oldest members. Throughout the whole of the first quarter of a century of its existence, I suppose that I was not without a seat on its Committee, in some capacity or other, more than for two or three years, and consequently had a voice in the shaping of its destinies. I think that all of us who took an active part in its organisation were highly gratified, and I think I may say astonished, at the rapidity and thoroughness of its success. Long may it prosper as a worthy monument to the memory of its founders!

NOTE.—As it is very probable that the man in honour of whose memory the Club was named may be but a shadow to some, it will not, perhaps, be amiss to give some few particulars as to his career, and one or two references to more extended biographies.

JOHN THOMAS QUEKETT was the youngest son of the head-master of Langport Grammar School, Somerset, and was born in 1815. He was apprenticed to his brother Edwin, a surgeon in London; studied at the London Hospital, and became a M.R.C.S. in 1840. He was appointed Assistant Conservator of the Hunterian Museum in 1843, and on the retirement of Professor Owen, in 1856, he was appointed his successor and Professor of Histology, which post he held until his death. He was elected a F.R.S. in 1860, and died in 1861. He was Secretary to the Microscopical Society of London for nineteen years, and elected as its President shortly before his decease. Of course, his book, "A Practical Treatise on the Use of the Microscope," is well known, as well as his "Lectures on Histology," always of great service to microscopists. See Mr. Farrant's Presidential Address, Mic. Soc. Lond., 1862; Mr. Michael's Presidential Address, Roy. Mic. Soc., 1895; Dictionary National Biography, etc., etc.



This Table Stage, designed by Mr. G. T. West, and exhibited by Messrs. Watson on May 19th, is intended to fit over the stage of a microscope, when placed in a vertical position. Obviously it will preserve the stage of a microscope, when corrosive or other injurious fluids are used; and when it is heated it will form a hot stage, the hands being protected by the attached wooden blocks. It forms also a convenient dissecting microscope, when it is used in conjunction with a loup holder.

It is a thoroughly practical and useful adjunct for a microscopist's outfit.

March 17th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. James Joseph Hall, Mr. Arthur Downs, Mr. Edward Larmer, F.R.M.S., and Mr. Frank Percy Smith.

The following donations were announced:—

"The Botanical Gazette"	In Exchange.
"The Journal of Applied Microscopy"	From the Publishers.
"Proceedings of the Scottish Microscopical Society"	From the Society.
"Proceedings of the Bristol Naturalists' Society"	" " "
Peregallo's "Catalogue of Diatomaceæ" ...	By Subscription.
Spitta's "Photo-Micrography"	From the Author.
"Annals of Natural History"	Purchased.

The President called the attention of the members to Dr. Spitta's work mentioned in the preceding list, as being one likely to be useful. It was extremely well illustrated, and specimen copies of the illustrations were placed upon the table. The book itself appeared to be most carefully and laboriously prepared, and if any one with some knowledge of photography took up the practice of photo-micrography he would no doubt find this book of very great assistance.

The thanks of the Club were cordially voted to the donors.

The Secretary announced that there would be an excursion by members of the Club to the Royal Botanic Gardens on April 8th. Members to meet at the entrance at 3 o'clock.

Mr. C. F. Rousselet read a note on *Trochosphæra Solstitialis*, a new species found in China and possessing some points of special interest which were illustrated by diagrams upon the board. A mounted specimen of this rare rotifer was also exhibited under a microscope in the room.

The thanks of the meeting were voted to Mr. Rousselet for his communication.

Mr. C. D. Soar read a paper on a new species of *Atax*, for which he proposed the name *A. Taverneri*.

The thanks of the meeting were voted to Mr. Soar for his very interesting paper.

Mr. Lewis Wright then gave a very interesting demonstration of the use of the latest improved form of lantern microscope as showing the advances made in this method of class illustration during the interval of fourteen years since he exhibited a lantern microscope to the Club. These improvements had been largely due to a better understanding of the relation between the aperture of the condenser and that of the objective as explained by Mr. E. M. Nelson. The condenser was now made of four lenses instead of three, by which arrangement most of the spherical aberration had been got rid of. The frame had been considerably strengthened in order to obtain greater steadiness for the fine adjustment, and the screen was made more highly reflective by being coated with a film of silver. This he had at first made with a plane surface, but found that the pictures in that case could only be seen by persons sitting in front of the screen. Subsequently he had finely ribbed or striated the surface in a vertical direction, with excellent results, the screen being rendered capable of showing the pictures equally well at a considerable angle on either side. In addition to these improvements, much better and more suitable object-glasses could now be obtained, and the substitution of electric for limelight illumination had enabled much higher powers to be effectively employed than was formerly possible. He regretted that the current available in the room would not suffice to supply his electric lamp, so that he should have to fall back upon the lime light; and although he should not with this be able to show the best effects attainable, possibly the comparison between what he could now do and what he was able to do fourteen years ago with the same means of illumination would be satisfactory. Mr. Wright then showed a large number of slides upon the screen under various powers, concluding the exhibition with some very excellent views of opaque objects shown with remarkable brilliancy and sharpness.

The President said that the Club was greatly indebted to Mr. Wright for giving them this very fine exhibition, and for the

great pains he had taken in the matter. He felt sure that all present must have felt that Mr. Wright was very heartily to be congratulated upon the perfection to which he had brought the instrument, and the great efficiency of it for the purposes of class demonstration.

April 21st, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club: Mr. W. H. Howard, Mr. C. G. Kiddell, Rev. G. H. Turner, Mr. H. Spence, Mr. E. J. Spitta, Mr. H. Spitta, and Mr. E. G. Wheler.

The following additions to the Library were announced:—

"Larvæ of British Butterflies and Moths" Vol. IV. Ray Society	By Subscription.
"Journal of Applied Microscopy"	From the Bausch & Lomb Co.
"Proceedings of the Academy of Natural Sciences of Philadelphia"...	From the Society.
"Proceedings of the Belgian Microscopical Society"	" " "
"Proceedings of the Geologists' Association"	" " "
"The Botanical Gazette"	In exchange.

The thanks of the Club were voted to the donors.

Mr. Hill on behalf of Messrs. Beck exhibited a new form of compressorium, being an adaptation of Mr. Beck's original reversible compressorium by Mr. Richard Davis. The construction and application of this cell were explained by reference to a coloured sectional diagram.

The President thought this would be found a very useful form of compressorium—a great point in its favour being that it was not very heavy owing to the frame being made of ebonite. Its construction made it very easy to manipulate, and it could be used equally well with either side up. He noticed, however, that the glass of one of the samples exhibited was already broken, and asked if there was any means of preventing this from happening when in use.

Mr. Hill said it could be readily avoided by not dropping it upon the floor, as had been done in this instance. He did not think it likely to occur from fair usage, with ordinary care.

The thanks of the meeting were voted to Messrs. Beck for this exhibit.

Mr. J. D. Hardy exhibited a new kind of cell for mounting objects, which he believed would be found to have some advantages over all those in present use. It was made of a glass ring placed upon an ordinary glass slide and fused to it by heat in a furnace; the ring and the slip became thus united in a way which rendered it quite impossible to become detached, or for any liquid to escape at the base. The only thing at present in use which possessed this advantage was the concave cell, but this required to be made in thick slide, and if the object was large it did not lie flat, whilst if small it was sure to get to the edge. He was unable at present to say what they would cost, but he thought not more than the ordinary concave slides.

The President said he did not mount in fluid himself, but he could assure Mr. Hardy that if he could tell them where cells of that kind could be procured at a reasonable cost, there would certainly be a great demand for them. All kinds of cells seemed to leak or get loose in course of time, but these being fused to the glass it was difficult to see how they could do either.

Mr. Hardy thought he should shortly be able to place sufficient of these cells in the hands of Mr. Curties to supply any members who liked to try them.

Mr. R. T. Lewis read a note "On some Australian Ticks received from Mr. C. J. Pound," the subject being illustrated by drawings and specimens.

The thanks of the Club were voted to Mr. Lewis for his communication, and to Mr. Pound for sending the specimens upon which it had been based.

Mr. Karop read a short paper on some amenities of botanical nomenclature, for which, on the motion of the President, the thanks of the meeting were cordially voted.

Announcements of excursions, etc., for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

May 19th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the meeting of April 21st were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club. Mr. Maurice Blood, M.A., Mr. John H. Garnar, Mr. F. L. Pochin, M.B., and Mr. G. T. West.

The following donations to the Club were announced :—

"Journal of Applied Microscopy" ...	From the Publishers.
"Proceedings of the Canadian Institute" ...	In Exchange.
" ,, ,, Manchester Literary and Philosophical Society" ...	,,
"Proceedings of the Nova Scotia Institute of Sciences"	,,
"Journal of the Royal Microscopical Society"	,,
"British Moss Flora," Part 19	From the Author.
"Proceedings and Bulletin of the United States National Museum" ...	,, Department.
"Report of the Smithsonian Institution" ...	,, Institution.

The thanks of the Club were voted to the donors.

Mr. Karop described a new electric hot stage by Reichert of Vienna, which had been sent to the meeting for exhibition by Mr. C. L. Curties. This ingenious contrivance was placed upon the stage of the microscope and connected to the house current through a contact-breaker which could be set to maintain the temperature constant to any required degree.

The thanks of the meeting were unanimously voted to Mr. Curties for sending this apparatus for exhibition, and to Mr. Karop for explaining it.

Mr. Watson Baker exhibited a new super-stage for the microscope for use when dissecting or employing liquids which it was desirable should not be allowed to fall upon the stage of the instrument itself. It had been made to the design of Mr. G. T. West. It was made of metal, but had wood blocks at the sides on which to rest the hands, and it could be used as a hot stage if so required.

The thanks of the meeting were voted to Mr. Baker for his exhibit.

The President said they had often to acknowledge their indebtedness to their very worthy Honorary Secretary, and he had now done them another very good turn. The Club had been in existence for thirty-four years, but had never had its history written; and Mr. Karop had induced Dr. M. C. Cooke, who was one of the Founders, to write its history for them. He therefore had great pleasure in moving that the heartiest thanks of the Club be given to Dr. Cooke for his kindness in the matter.

This proposition having been put to the meeting was carried with acclamation.

The President said that Mr. F. Enock had been kind enough to come that evening to give them an account of the life-history of the Tiger Beetle.

Mr. Enock said that their indefatigable Secretary had often asked him to come down to the Club and give them one of his lectures, but he had always been prevented hitherto by other engagements. He had, however, great pleasure in being there that evening, and would give them the results of his observations upon the life-history of the tiger beetle, which it had taken him seventeen years to complete. He then proceeded to narrate the life-history of this well-known beetle, illustrating the subject with a number of admirably drawn lantern slides, with some clever lantern effects.

Mr. Karop was sure those present had all listened with extreme pleasure to Mr. Enock's most interesting lecture, and would agree with him that his importunity in this instance had had a very gratifying result. He should like to express his own thanks, as well as those of the Club, to Mr. Enock, and at the same time to say that he would add still further to their obligation if he would furnish them with some notes of his address for publication in the Journal. He had much pleasure in moving that their best thanks be given to Mr. Enock for his very great kindness in coming to give them this lecture.

Mr. Enock said he should be very pleased to give the Club some notes for the Journal.

The President hoped he might be allowed to add his own thanks to those which had already been expressed for this very interesting and very instructive lecture; he had never in his life

heard one which was more interesting, and as regarded the very beautiful illustrations he could only say that they were quite unique in his experience.

The thanks of the meeting were then voted to Mr. Enock, with acclamation.

Announcements of the meetings and excursions for the ensuing month were then made, and the meeting terminated.

June 16th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. Henry Austin, Mr. Duncan S. Miller, Mr. James Wedeles.

The following donations to the Club were announced:—

"Proceedings of the Manchester Literary and Philosophical Society" ...	In Exchange.
"Journal of Applied Microscopy," May and June	"
"The Botanical Gazette"	"
"Proceedings of the Geologists' Association"	"
"Annals and Magazine of Natural History"	Purchased.

Mr Karop said that an opportunity now offered to such members as desired to become possessed of a copy of Ehrenberg's "Micro-Geological Studies," a work which was not in their library. It was proposed to reproduce the original plates of "Polycestinæ," etc., by photography, and to issue these with the text if a sufficient number of persons would join in sharing the expense. Intending subscribers were asked to give in their names.

Dr. M. C. Cooke's paper entitled "Early Memories of the Q.M.C.," referred to at the previous meeting of the Club, was read by Mr. Karop.

The President said that those members who were present at their ordinary meeting in May would no doubt remember that

when the announcement was made that Dr. Cooke had kindly promised to write this paper, a very hearty vote of thanks was given to him in anticipation, and now that it had been read he was sure they would not only renew their thanks but would also pass a no less hearty vote of thanks to their honorary Secretary for reading it.

Mr. E. M. Nelson described by means of diagrams drawn on the board the construction of a new form of eyepiece which was shown to possess some advantages over those in common use. The theory on which the Huyghenian and other eyepieces were constructed was also explained, and the differences between these and his new form were very clearly pointed out.

The President was sure the members would be very much obliged to Mr. Nelson for the explanations he had given. As regarded the new eyepiece he could say that he had enjoyed the opportunity afforded him of using one, and could only say that he found the No. 12 a simply delightful eyepiece to work with. He tried hard, but could not find any difference between this and the compensating eyepiece when used with an apochromatic objective.

Mr. Neville would like to thank Mr. Nelson for the way in which he had explained these eyepieces; he had usually managed to soar above their heads in the region of mathematics, but this time he had come down more to the level of most people, and had given them not only a simple description of how the best definition was obtained, but the best mathematical explanation also. He had himself been dabbling a little in optics, but working by rule of thumb, and had given some attention to eyepieces, and had tried to get as good an eyepiece as possible with a large field. He had done this by taking an ordinary eyepiece and bringing the lenses much closer together than usual, and this increased the field considerably. Mr. Levy had a short time ago exhibited an eyepiece at one of their meetings which immediately arrested his attention from its excellent definition and its very large field, it was so good that he hoped Mr. Levy would tell them how it was constructed. He was very glad to find that so much attention was now being given to the subject, for he thought it most important that they should have good eyepieces as well as good objectives. Some time ago, when they had a number of microscopes in the room, he could not help noticing the very limited

field in Zeiss's eyepieces; he thought this was a very great defect, and it seemed as if whilst opticians had been striving to produce perfection in the objectives and the stands, they had to a large extent overlooked the need for perfection in eyepieces.

Mr. J. D. Hardy asked if Mr. Nelson could tell him what was the power of this eyepiece, and if was applicable to the telescope.

Mr. Nelson said the power was 12, but a higher power could be made. The difficulty experienced in obtaining a large field with good definition all over it was due partly to the objective, which would not always stand it. Multiple eye-lenses used to be common at one time, and there were some examples of these in the Royal Microscopical Society's collection. A lens could always be divided in that way, and by so doing the aberration was reduced. He quite agreed that opticians had not given the attention to eyepieces which they ought to have done. All the compensating eyepieces were over-corrected so as to make up for the under-correction of the apochromatic objectives. If, therefore, a properly corrected objective was used with an over-corrected eyepiece it ought to fail. Experience showed, however, that they were not all alike, but both objectives and eyepieces had very different amounts of under- and over- correction.

The Secretary said that as their next ordinary meeting would not be held until October, it was not worth while to give out notices for three months, but he hoped new members would bear in mind that the meetings would still continue to be held on the usual evenings as "gossip nights." He hoped the members, who would no doubt many of them be leaving home before they met again in that room, would have a very pleasant vacation, and that one result of their holiday excursions would be some more papers for the Club.

The proceedings then terminated with the usual Conversazione.

NOTICES OF RECENT BOOKS.

Les Diatomées Marines de France. H. and M. Peregallo. Published by J. Tempère, 168, Rue St. Antoine, Paris. Part 1st, Raphideæ; Text, pp. 236; Plates 1 to 50; price 50 francs.

This excellent work on the marine diatoms of France, and, of course, of those other countries, as our own, which are washed by the same seas, the Mediterranean excepted, has appeared serially in "Le Micrographe Préparateur," issued bi-monthly by the same publisher, and is likely to become indispensable to all diatomists. Originally intended to supplement the well-known Synopsis of Van Heurck, by the addition of the rich diatom flora of the Mediterranean, the authors received such encouragement from various sources that they decided to put together an entirely new and complete account of the diatoms of France in three parts, of which the present is the first.

The descriptions appear to be well drawn up, full without being tedious, and not overburthened with too copious a synonomy, while all measurements have evidently been carefully revised.

Naturally in such a work the plates form a very considerable feature, and taking them all round they are worthy of great praise; the outlines are accurate and not spoilt by the markings—indeed, if we desired to be hypercritical, we should say these latter were even too sharp and neat—but the draughtsman has wisely refrained from giving the details of striation in the pleurosigmas and allied finely-lined forms. Another advantage consists in nearly all the drawings being on the same scale, viz., 900/1, reduced by a photographic process to 600/1, except in the case of such huge forms as Isthmia, and some of the Biddulphias, where they are still further reduced.

Altogether it is a very good book on a subject of perennial interest to microscopists, and we look forward with interest to its continuation.

A Text-Book of Plant Diseases. By George Massee, F.L.S., pp. xi., and 458, 89 figs. in text. London: Duckworth & Co., 1899. Price 5*s*. net.

The study of Vegetable Pathology has of late years made very rapid strides, and considering its vast importance, as affecting the chief food substances of man and animals, it is second only to the study of the diseases directly concerning ourselves. Putting aside the sufficiently serious ravages to the plant world caused by insect larvæ, coccids, and so forth, probably the greatest danger to our crops, orchards and gardens, lies in the attacks of the lower orders of plants, viz., fungi and bacteria, especially the former, which are able to and often have devastated whole regions, and so brought about ruin, distress and famine. From his position as principal assistant in the cryptogamic department at Kew, few men in this country possess more knowledge or have better opportunities of studying these pestilential, but extremely interesting, foes than Mr. Massee; and his work on Plant Diseases should be as valuable to the farmer and horticulturist, who will take the trouble to digest it, as it certainly is interesting to the mere microscopist or botanical student. The various diseases and the particular fungi, etc., which cause them, are treated of as fully as the limits of the work permit or the ability of the class, for which it is presumably chiefly intended, to understand allows; indeed we fear, as it is, it may be beyond the grasp of all but the more modern native agriculturists, who have had the benefit of a special training. The references to authorities and monographs are sufficiently full, and the figures mostly good, but of the preventive or other treatment we have no right to say more than that it probably represents the best modern practice. The two indexes, of parasites and of host plants, make reference easy, and are not the least useful feature of a very admirable book.

The Cambridge Natural History, Vol. VI. (Insects, part 2). By David Sharp, M.A., M.B., F.R.S., etc. Pages 601, figs. 293. McMillan & Co. Price 17*s.* net.

After a lapse of four years since the publication of vol. v. the oft-promised vol. vi. has at length appeared, and continues and concludes the History of Insects. It will be remembered that in vol. v. the Aptera, Orthoptera, Neuroptera, and the parasitic Hymenoptera were dealt with, in the present volume the remaining families in the last named order are described, the Coleoptera, Lepidoptera, Diptera, Aphaniptera, Thysanoptera, Hemiptera, and Anoplura being afterwards severally considered.

Of the eight chapters into which this volume is divided, the first three are devoted to Bees and Wasps, the characters of each sub-family being clearly stated; fifty-two illustrations are interspersed amongst the text, the natural size being in all cases indicated where the figures have been enlarged. The many pages relating to the habits and instincts of bees will prove by no means the least interesting portion of the volume to the general reader. In chapter 4 the Ants are similarly treated, thirty excellent figures being given in illustration. In chapter 5 the Coleoptera are systematically described, and the distinctive characters given of no less than eighty-five families, types of most of these being specially figured—the microscopic structure of the mouth organs, feet, etc., being also in addition frequently shown. Chapter 6 deals exclusively with the Lepidoptera, the first forty pages containing a careful description of their structure, development, and classification, these being followed by some account of each of the forty-seven families into which this order is divided. Chapter 7 treats somewhat more briefly of the Diptera, Aphaniptera, and Thysanoptera, and amongst the illustrations given, we easily recognise on p. 503 a figure of Diopsis taken from a specimen which excited much interest when shown at one of the meetings of the Q.M.C. In the eighth and last chapter an account is given of the Hemiptera, Homoptera, and Anoplura, and here, as elsewhere in the volume, excellent figures are given, as well as useful foot-notes referring to bibliography.

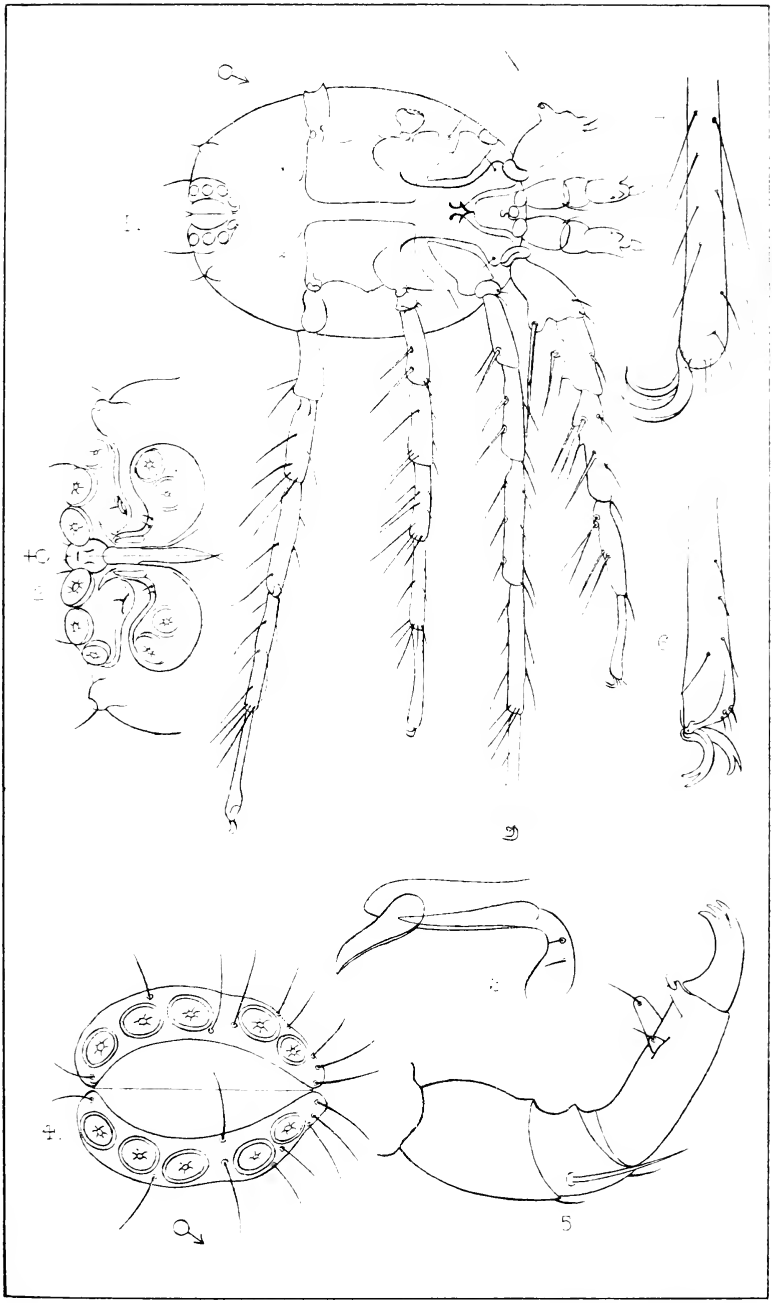
As in vol. v., a very complete index of the contents is given, extending over twenty-five pages, in which, by the simultaneous

use of thick and thin type, a reference to either figures or text can be obtained at a glance.

The illustrations throughout do the highest credit to the artist, and, except where copied from figures in other works, leave little to be desired as to correctness of detail or skilful execution. In some few instances, however, as in the case of Aleurodes on p. 591 (after Heeger), where the special characteristic, called by Maskell the vasiform orifice, is omitted to be shown, the authority copied from is primarily to blame.

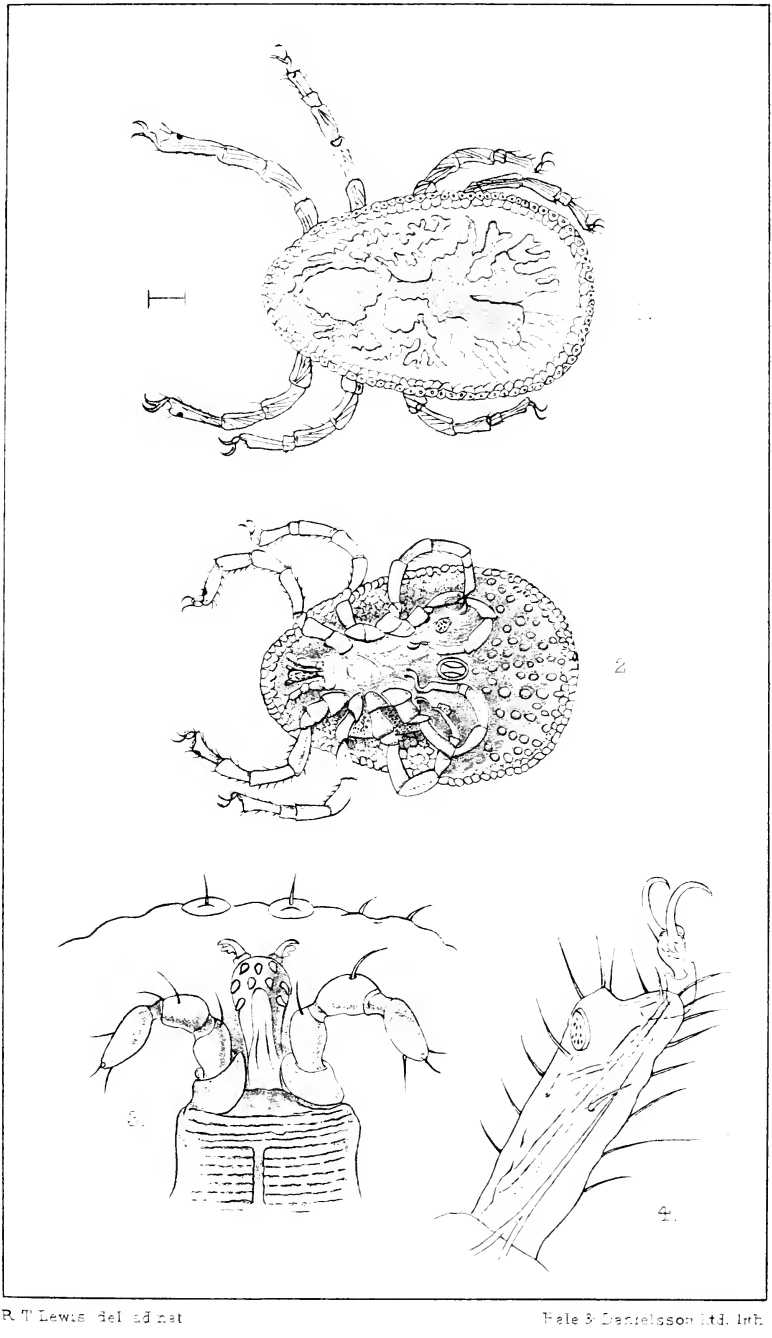
As a work of ready reference these volumes will doubtless be of great value to students and workers in this branch of Natural History, whilst those desiring a fuller acquaintance with any particular group will find foot-notes referring them to the best authorities. The ordinary reader will, however, find much here to interest and instruct; and after noting that the known species of Coleoptera are said to number 150,000, and those of the Lepidoptera 50,000, he will probably lay down the book with a feeling of wonder—not that the work has been so long in hand, but that it has been possible from so wide a field of research to collect and to compress so much information in so short a time.

Dr. Sharp has not only given us a remarkably clear resumé of what is known as to the life-history and habits of insects, but he has never hesitated to point out where our knowledge is at fault, indicating thereby in numerous instances directions in which there are still lines of enquiry waiting to be followed up. He is greatly to be congratulated upon the successful issue to which he has brought his section of this great work.



C. D. Soar, del.

Bale & Danielsson, Ltd. lith.



R. T. Lewis del. ad nat. Bale & Danielsson Ltd. lith.

On an Undescribed British Sponge of the Genus *Raphiodesma*, Bowerbank.

By J. G. Waller, F.S.A.

(*Read October 20th*, 1899.)

Plate 14.

The Sponge which I bring before your notice, as one not hitherto described, has been in my possession about twenty years. When found by me on the shore at Paignton, Torbay, it was not bigger than an ordinary filbert, and nearly orbicular. At the first examination I saw that it had some differences from those known to me, and marked my slides as reserved for future study. It will be admitted, that I have not been in a hurry to inflict upon you as new, what might have been already described elsewhere; and until Dr. Bowerbank's work on the British Spongiadæ was completed, I might easily have made such an error. But time flies, I may say has flown, as several years have passed since I made any communication to you; I feel, therefore, that, with matter in hand, I owe you a duty.

It is unfortunate that our Society has so few amongst its members who make a study of the sponges: more students are certainly wanted in a class so full of interest. But we have also to lament a distraction amongst the learned specialists in attempted classifications, wherein they seldom agree, with terminology always being added to, always being altered, rendering it necessary for us to go to school again, with the unhappy prospect of learning what may be pronounced obsolete in a year or two, or pushed aside by another. It is very difficult to see how science is really advanced by this process. What one does feel is, that, some day, there will be a formidable dust-heap of scientific terms. I shall save you distraction in my own case, as I intend to go no farther than Dr. Bowerbank, whose work, whatever may be its defects, is nevertheless, in general, of admitted simplicity in its arrangement, and it answers my purpose.

Classifications are all artificial; few genera or species are so absolutely distinct but that they may be found occasionally to overlap one another. It is this indeed that adds so much interest to the study of natural history in all its departments. The example, about to be considered, appears to me to have this interest.

The genus *Hymeniacidon*, of the author referred to, is characterised by a very irregular distribution of the spicules in the formation of the skeleton. Out of this genus he made another, which he called *Raphiodesma*, on account of some of the spicules assuming a fasicular arrangement, in parts at least. Besides this, there were other special forms: notably, minute spicules of an anchorate shape, making rosettes upon the membranes, as well as otherwise dispersed. Foreign observers had already noted these characters, and given a name to a large cognate class—viz., *Esperia*, from Esper the naturalist. Another feature is also pretty constant—viz., that the skeleton spicules are chiefly acuate, varying to the fusiform in the shaft with a pin-like knob.

Now, this example differs from others in having two kinds of spicules in its skeleton—the acerate, of the variety called fusiform, and the acuate, with variations as above given. The skeleton conforms to the characters expressed by Dr. Bowerbank under his genus *Hymeniacidon*. The somewhat stout dermal membrane, however, has, besides the spicules similar to the skeleton, fine hairlike forms which, here and there, make up fasciculi, though slightly compacted together. Intermingled with these, though sparsely, are very fine tricurvate spicules, and occasional bihamate ones, with no or very slight variations in the thickness of the shaft. Now these forms are common to the genus *Raphiodesma* and its allies, though the bihamate spicule is generally contort—that is, has its terminals twisted in different planes. The examples in this instance appear to keep to the same plane, though it is not easy to determine this point when they are seen *in situ*; still this is not without a parallel, to which I shall refer.

I now come to the form of spicule which is almost invariably associated with the genus referred to—viz., the anchorate, and that specialised as inequipalmate anchorate, tridentate, and bidentate. These, which are now generally called "flesh spicules," have a special interest in their varying shapes, and also in the

extreme difficulty in accurately delineating them. Few of these figures, though beautifully executed, are sufficiently defined in the "British Spongiadæ," and in many instances do not seem to be quite understood. But the late H. J. Carter's representations are very different: nothing can be more precise and accurate; especially when we consider how very easy it is to make a mistake by omitting important, but obscure details. The same care is also to be found in the figures given in the *Challenger* reports. It was Mr. Carter, however, who first described these spicules in all their details, accompanied by renderings which commend themselves by their truth. I shall here, in presenting before you the forms found in this sponge, compare them with what are seen in genera or species with which I think this must be associated.

And one cannot trust to any description but what is general, and illustrations are inevitable. But before one does this it may be well to quote some observations on "flesh spicules" as given in a paper by Professor K. A. Zittel on fossil Hexactinellidæ, in the *Annals and Magazine of Natural History*, 4th series, vol. xx., p. 272. He says, "If we take our stand on the ground of the transmutation theory, we certainly have before us in the flesh spicules those parts of the sponges which change most readily by adaptation, and therefore most easily throw off the original type." Every one who has had any experience must assent to this; and, in now placing before you some examples, it will be easy to affirm the wisdom of these remarks, and how utterly useless it would be to use them as distinctive of species except in general terms. The changes which take place in vegetable forms from very slight causes, as displayed in our gardens, teach us that nature rejects the restriction of species. It is, however, a scientific necessity to mark changes observed in cognate organisms by an addition to the generic term, but this should be done with judgment and with as much simplicity as possible.

To return to those details which seem inevitably to point out the group under which this sponge must be arranged: they consist primarily of those fasciculi which distinguish the genus *Raphiodesma*, as well as those anchorate spicules of the character belonging to it, and the tendency to form rosettes, though incomplete, at least in the specimen under consideration. Also the associated forms, tricurvate, and those I arrange under bihamate, though doubtful of the accuracy of the term as terminal hooks are

obscure, all tend to show the alliance. But all these subsidiary spicules show a feeble or imperfect development.

One or two species given in the *Challenger* reports show a close analogy in the associated forms alluded to; in some cases they are almost identical. I refer to *Esperiopsis symmetrica* in which similar bihamates appear, and to *Esperella fusca* in which the anchorate spicules are as near as possible the same; I might also refer to others therein figured, though the resemblances are less obvious in these cases.

The form of spicule belonging to the skeleton, distinguishing this from any other of the genus referred to, is the large acerate, subfusiform, which is associated with the acuate, typical of *Raphiodesma*, and its close ally *Desmacidon*; and it is this fact which makes the specimen interesting and which I considered thus to demand a description. I propose to name it *Raphiodesma affinis.*

Description.

Sponge subrotund, in dry state fawn-colour. Dermal membrane, stout, spiculous. Hair-like acerate spicules disposed somewhat in fasciculi, others singly dispersed, small. Larger acerate spicules, few in number, also acuate spicules irregularly dispersed. Anchorate spicules, tridentate, bidentate, inequipalmate. Skeleton, composed of large acerate spicules irregularly disposed, with a somewhat open rete. With these also acuate spicules as in membranes. Sometimes, on the latter, the anchorate spicules show a tendency to the forming of rosettes, but not complete. Besides this, it also exhibits in its structure very delicate tricurvate spicules, and some curved forms, bihamate irregularly developed.

Explanation of Plate 14.

Raphiodesma affinis n. sp.

Fig. 1. Arrangement of spicules on dermal membrane. × 200.
,, 2. Part of skeleton in section. × 150.
,, 3. ,, ,, ,, × 200.
,, 4. ,, ,, ,, × 150.
,, 5. Anchorate spicules, front and side views. × 1200.
,, 6. Acerate spicule (upper) × 210, and acuate spicule (lower) × 260.

Radiolaria.

By Arthur Earland.

(*Read November 17th*, 1899.)

Plates 15 and 16.

The Radiolaria, which are of exclusively marine habitat, form an order of the class Rhizopoda, and have in general the characteristic organisation of that class, but they differ from all other Rhizopoda in the fact that their unicellular body is divided by a porous membrane, known as the capsule membrane, into two clearly marked portions, a central capsule containing one or more nuclei, which may be considered mainly as the organ of reproduction and sensation, and an extra-capsulum with a calymma, or "jelly-veil," from which the pseudopodia diverge. The extra-capsulum may be regarded mainly as the organ of nutrition and motion. The sarcode of the two portions communicates by means of openings in the capsule membrane. Nearly all Radiolaria develop a skeleton for support and protection, and these skeletons present a most wonderful variety of forms. In the first, third, and a part of the fourth legions the skeletons are purely siliceous, but in the second legion, the Acantharia, the skeleton is always composed of an organic substance of a chitinous nature, known as acanthin, while the majority of the fourth legion have a skeleton composed of a silicate of carbon. Calcareous skeletons are unknown in the Radiolaria. The Radiolarian cell in most instances leads an isolated and separate existence (Monocyttaria), but in a few genera of the first legion, the Spumellaria, a number of individuals combine to form a colony or *cœnobium* (Polycyttaria).

It will be seen from the foregoing definition that the most important character of the Radiolaria is the differentiation of the unicellular body into two principal parts of equal importance, and the separation of these two parts by a constant capsule membrane.

The importance of the capsule membrane was first indicated by Haeckel in his monograph "*Die Radiolarien*," published in 1862, and his conclusions have been endorsed by Hertwig and other workers. The capsule membrane appears to be almost invariably present at one time or another of the Radiolarian life, and is usually persistent for the greater part of its existence, but in some species the membrane is only formed immediately before sporification, and lasts but a short time. It possesses great power of resistance to chemical and physical reagents, combining density with elasticity in a high degree. It is an extremely thin and delicate membrane, usually structureless except for its apertures, and hence may be easily overlooked; but its presence may always be detected by means of staining fluids or other suitable reagents.

In all Radiolaria the membrane is pierced with definite openings through which the extra-capsular protoplasm communicates with the sarcode in the interior of the capsule, and as these openings or "pylæ" (= gates) show characteristic or constant features, they have been utilised by Haeckel as a basis for the classification of the Radiolaria, which he divides into four legions:—

(1) Peripylea or Spumellaria.
(2) Actipylea or Acantharia.
(3) Monopylea or Nassellaria.
(4) Cannopylea or Phæodaria.

In the first legion, the Peripylea or Spumellaria, the capsule membrane is single and perforated by numerous extremely fine pores equally distributed over the whole of its surface.

In the second legion, the Actipylea or Acantharia, the capsule membrane is single and also perforated by numerous extremely fine pores; but they are fewer in number than in the first legion, and are marked off into regularly arranged groups or lines by imperforate intervals.

In the third legion, the Monopylea or Nassellaria, the capsule membrane is also single, but possesses only one large opening or osculum. This is situated at the basal pole of the main axis, and is closed by a circular perforated lid (*operculum porosum*). Seen from the surface, this lid appears as a clearly defined porous area (*porochora* or *area porosa*) and forms the horizontal base of a peculiar "pseudopodial" cone, which stands vertically in the

interior of the capsule, and may be designated the "thread cone" (*podoconus*). See Figure 3A.

In the fourth legion, the Cannopylea or Phæodaria, the capsule membrane is double, and possesses only a single large main opening or osculum, which is situated at the basal pole of the vertical main axis and is closed by a circular radiated lid (*operculum radiatum*). This operculum appears when examined from the surface as a sharply defined stellar area (astropyle) from the middle of which arises a shorter or longer cylindrical tube, the proboscis. Most Phæodaria also possess several (usually two) smaller accessory openings or "parapylæ," generally near the aboral pole of the main axis. See Figure 4A.

From the foregoing definitions it will be seen that the four legions fall naturally into two pairs. The first and second legions, the Peripylea and the Actipylea, agree in having the capsule membrane pierced with numerous fine pores, but have no principal opening or osculum. The third and fourth legions, the Monopylea and Cannopylea, have as a rule but a single osculum, at the basal pole of the vertical or main axis. The first and second legions, therefore, are formed into a separate group, the Porulosa or Holotrypasta, and the third and fourth into another group, the Osculosa or Merotrypasta.

The Central Capsule and its Contents.

The central capsule of the Radiolarian cell is, in its origin, no doubt, a geometrical sphere, with all parts concentrically and evenly arranged round its centre, the nucleus. This primary spherical form, however, becomes modified in most Radiolaria into various secondary forms, which are chiefly dependent on the formation of the skeleton. The central capsule, increasing in size after the formation of the hard skeleton has begun, has of course to adapt itself to the shape and growth of that shell. Passing through the interstices in the skeleton, it frequently reunites outside it, so that parts of the skeleton become enclosed in the capsule, although, except in one legion, the Acantharia, the skeleton is *always* originally formed outside the central capsule.

Normally the central capsule consists of three parts: (1) The capsule membrane, the nature of which has already been described;

(2) The enclosed endoplasm or intra-capsular protoplasm; (3) The nucleus. In addition to these constant elements it also often but not invariably contains other features, such as:—

(4) An internal or intra-capsular skeleton.
(5) Intra-capsular vacuoles or alveoli.
(6) Fat granules or oil granules.
(7) Crystals of differing composition.
(8) Pigment granules.
(9) Amyloid concretions.
(10) Xanthellæ or "yellow cells."

The Nucleus.

The nucleus of a Radiolarian is a large true cell nucleus, placed either in the centre of the capsule, as in most Peripylea, or ex-centrically, as in most other Radiolaria. At first solid, it usually differentiates later into an outer dense nuclear membrane, and an inner softer or fluid content, either with a single nucleolus or a variable number of nuclei. This division of the nucleus into nucleoli takes place at different periods, so that the Radiolaria may be divided into precocious and serotinous. The bulk of the Radiolaria belong to the latter or serotinous division, as the division of the nucleus is deferred until shortly or immediately before the process of spore formation. The nucleus then breaks up rapidly into numerous small nuclei, sometimes thousands in number, and each of these either becomes in itself the nucleus of a swarm spore, or by repeated division gives rise to a group of spore nuclei. But all the social or colonial Radiolarians (Polycyttaria) and most of the Acantharia are precocious, for in them the nucleus divides early in the life history of the cell, which is therefore multi-nuclear during the greater part of its existence.

The Endoplasm.

The intra-capsular protoplasm or endoplasm is originally, and in the earliest stages, the only important content of the capsule except the nucleus. In this condition, which in some of the smaller Radiolaria persists for a long period, the endoplasm appears as a homogeneous, colourless, and finely granular mass, having no definite structure and in particular no fibrillar net-

work. In most Radiolaria, however, it very soon undergoes modification, being differentiated more or less into an internal granular medullary substance and an external fibrillar cortical substance. Various products of the sarcode also make their appearance, especially the hyaline spheres (vacuoles and alveoles) fat, oil and pigment granules, and occasionally crystals.

The endoplasm is doubtless used mainly for the purposes of propagation, becoming divided earlier or later into numerous small particles, each of which, surrounding a particle of the divided nucleus, forms with it a flagellate spore.

Intra-capsular Hyaline Spheres.

The central capsule of many Radiolaria contains in its endoplasm numerous spherical bodies of varying size, consisting of a watery or albuminous fluid. They were originally described as nuclei, but modern histological methods have disproved this. They are of two kinds, *vacuoles* and *alveoles.* The vacuoles are merely spherical drops of fluid, devoid of any special envelope, but immediately surrounded by the endoplasm. The alveoles, on the other hand, are true vesicles, enclosing a drop of fluid or jelly. Both vacuoles and alveoles occasionally contain various formed constituents, such as oil globules, fat granules, pigment granules, crystals, etc. It may be assumed that the vesicular alveoles are developed from the drop-like vacuoles by the increase in size accompanied by the precipitation of a vesicular envelope from the endoplasm. The character common to all hyaline spheres, whether vacuoles or alveoles, is their aqueous, not adipose, constitution, and their clear structureless appearance, only the above-mentioned enclosures being visible in them. Their refractive index varies greatly, probably as the result of corresponding variations in their constitution.

Intra-capsular Fat Granules.

All Radiolaria contain more or less fat or oil in their central capsule. It generally appears as numerous small spherical granules, either free in the endoplasm or enclosed in the vacuoles. In addition to these small fat granules, which are always present, the central capsule of many Radiolaria contains also larger fat globules. They are especially notable in the Polycyttaria or

social Radiolarians, in which the central capsule often contains a single large oil globule, which may occupy a third of its diameter. The oil globules are usually colourless and highly refractive, but occasionally they are yellow, brown, rose-coloured, or even a deep blood-red in colour. Physiologically they are of the greatest importance. Firstly, they diminish the specific gravity of the organism, thus neutralising the increase of the specific gravity due to the growth of the skeleton. Secondly, they are probably used as a reserve store of nutriment. In this latter respect it may be noted that in the process of spore formation each flagellate spore usually contains a fat granule.

Intra-capsular Pigment Bodies.

Most living Radiolarians have the central capsule coloured. The colour is always due to the formation of definite pigment granules, sometimes distributed evenly through the endoplasm, sometimes aggregated in one spot. They vary in dimensions, but are usually too small to be measured, appearing under even a high power as fine dust. Their chemical constitution is unknown. The commonest colours are yellow, red and brown; violet and blue are rare, green still rarer. Sometimes a definite tone of colour obtains through the members of a whole group, and the same colour is usually constant in individuals of a species.

Intra-capsular Crystals.

Crystals are frequently found in the central capsule, and are of two kinds, small and large. The small or "spore crystals," which are widely distributed among the Porulosa, are rod-like or spindle-shaped bodies, consisting of an organic substance which probably serves as a reserve of nutriment for the developing spore, since each swarm spore often contains a crystal. The large crystals, on the other hand, have only been observed in a few of the social Radiolarians (Polycyttaria), and are probably to be regarded as excretory products.

Intra-capsular Concretions.

Concretions of different shapes and constitution are found in the endoplasm of a few Radiolaria. They are usually circular or

elliptical discs, concentrically laminated and highly refractive, resembling starch grains. Twin forms have been observed, as though they were in process of division. Their constitution and value are unknown.

Intra-capsular Xanthellæ.

The xanthellæ or symbiotic yellow cells are found in the central capsule of one legion only, the Acantharia. In the other three legions they occur only in the extra-capsulum. Their nature and significance will be discussed later on.

The Extra-Capsulum.

The extra-capsulum includes all those parts of the soft body which are outside the central capsule, and may be regarded mainly as the organ of nutrition and motion. It consists of the following constant parts:—(1) The calymma or "jelly-veil"; (2) The exoplasm or extra-capsular sarcode, which may be subdivided into (*a*) The sarcomatrix or layer of exoplasm immediately surrounding the membrane of the central capsule; (*b*) the sarcoplegma or irregular network of exoplasm ramifying through the calymma; (*c*) the sarcodictyum or network of exoplasm covering the outer surface of the calymma; (*d*) the pseudopodia, which, originating in the sarco-matrix, pierce the calymma, on the outer surface of which they form the network of the sarcodictyum, thence radiating freely from its nodal points into the surrounding water.

Besides these two constant elements, the extra-capsulum very frequently but not invariably includes certain other enclosures, such as:—

(3) An external or extra-capsular skeleton.

(4) Extra-capsular vacuoles or alveoli.

(5) Fat granules or oil globules.

(6) Pigment granules, or in the fourth legion the peculiar body known as the *phæodium*.

(7) Xanthellæ.

The Calymma.

The most voluminous portion of the extra-capsulum is the calymma, or thick gelatinous mantle which completely surrounds the central capsule, from the outer surface of which, however,

it is separated by a thin but continuous layer of exoplasm, the sarcomatrix. The calymma is difficult to detect in the living Radiolarian, for the gelatinous substance of which it is composed is perfectly pellucid and colourless, and possesses the same refractive index as sea-water. Its presence may be demonstrated by staining the specimen with carmine, which penetrates very slowly into the mass. In dead specimens it is more readily observed, owing to the fine particles of matter which adhere to its viscid surface.

The calymma of most Radiolaria appears as a fine structureless mass, containing neither fibres nor enclosures. In some groups, however, definite structural characters become developed. The most striking is the formation of alveoles, which in some cases are so numerous that the calymma assumes the appearance of a frothy mass composed of large, clear, thin-walled vesicles. Occasionally the calymma appears to be built up of thin concentric laminæ; this perhaps may be due to differing quantities of water in successive layers.

In consistency the calymma varies from a very soft jelly, offering little resistance to pressure, to a firm gelatinous shell, almost cartilaginous in its hardness and elasticity.

The form and volume of the calymma varies at different times in the life history of the Radiolarian. In most forms it originates as a sphere, in the centre of which lies the central capsule. On the outer surface of this spherical or primary calymma, the primary lattice shell is deposited in nearly all Radiolaria. Hence it will be seen that the firmness and elasticity of the calymma has considerable mechanical significance in the skeleton-forming Radiolaria. After the formation of the primary skeleton, the jelly-veil continues to grow, until at last in most forms it encloses and surrounds the whole of the shell, assuming in consequence the most varied forms.

As already mentioned, the calymma may contain both vacuoles and alveoles. In structure and contents they resemble those in the central capsule which have already been described. Their size varies greatly, but as a rule large vacuoles are extremely rare, except in certain groups, all of which belong to the skeletonless Radiolaria. In these groups the vacuoles and alveoles lie usually in layers increasing in size from the centre outwards. It seems possible that in these groups the alveolar structure,

which, by very largely increasing the volume of the calymma, must at the same time increase its power of mechanical resistance, has been developed as a means of protection, and in lieu of the ordinary defensive skeleton.

Fat granules are widely distributed in the exoplasm of Radiolaria, appearing usually as small, dark, highly refractive bodies, sometimes coloured. They are very likely products of digestion. Larger oil globules also occur, especially in the social Radiolaria (Polycyttaria), in which they are sometimes abundant.

The formation of extra-capsular pigment is rare apart from the phæodium of the Phæodaria. Considerable masses of pigment, usually black or blue, rarely brown or red, are found in a few Radiolaria. The composition and value of these exceptions to the rule are unknown.

The Phæodium of the Phæodaria.

The fourth legion, the Phæodaria, is distinguished from all other Radiolaria by several special features, such as the possession of a double membrane of the central capsule, the peculiar structure of the main opening or astropyle, and the constant presence of a large mass of extra-capsular pigment. This mass has been called the Phæodium, and the constituent granules Phæodellæ. It possesses a peculiar constitution and significance, which separate it entirely from the extra-capsular pigment granules observable in many other Radiolaria. The phæodium is always excentric in position as regards the central capsule, surrounding the oral half in the form of a voluminous concavo-convex cap, and hiding the astropyle at the basal pole of the capsule so completely that it is rarely visible until the phæodium has been removed. The central capsule is generally almost entirely imbedded in the phæodium, so that only its aboral pole projects. The "proboscis," which in all Phæodaria rises from the astropyle, is entirely surrounded by the phæodium, the volume of which is generally about equal to that of the central capsule, though occasionally it is much larger.

In colour the phæodium is always dark, usually olive green or blackish brown, rarely reddish brown or black. It consists of a mass of large and small phæodellæ varying from hundreds to thousands in number. They differ in size as well as in intensity of colour, and are irregularly crowded in a black powder-like

substance. In shape the individual phæodella is usually spherical, sometimes ellipsoidal or lenticular. Their size varies from very large specimens, ·04 mm. in diameter, to very small, ·001 mm. or less. Perhaps an average size would be ·015. Haeckel, who first described the phæodellæ in 1862, stated that a great part of them were true cells, composed of a nucleus and protoplasm and enveloped by a membrane. Many of the preparations mounted on board the *Challenger* confirm the cellular nature of these organisms, but others, made at the same time and by the same method, give no sign of nucleated cells, so that their nature is still problematical.

The physiological value of this curious feature is also a matter of conjecture. That it must be of the highest importance for some vital function can be conjectured from its size and constant presence, while the fact that it is located round the astropyle or main opening of the central capsule has led to the supposition that it is in some way connected with the nutrition and metastasis of the Phæodaria. In this connection it may be mentioned that the xanthellæ or yellow algoid cells, which have been found living symbiotically in the bodies of many Radiolaria of the other three legions, and which probably play a considerable part in the life history of the organisms, are apparently absent in all the Phæodaria. Nor does it seem possible that they could exist there, for most Radiolaria of this legion are deep-sea forms, living in icy cold and eternal darkness. Hence it has been surmised that their place in the Phæodaria is supplied by the phæodellæ, which may possibly be some lower form of algal life, capable of evolving oxygen under the influence of the phosphorescence of deep-sea animals.

The xanthellæ, which are frequently but not invariably found in the extra-capsulum, will be described later in connection with the life history of the Radiolaria.

The Exoplasm or Extra-capsular Protoplasm.

Although there is a constant interchange between the intra-capsular and extra-capsular protoplasm through the openings in the capsule membrane, the two portions of sarcode show certain fixed and characteristic differences, due to the physiological division of labour between the central and peripheral parts of the

body, and their consequent morphological differentiation. The extra-capsular protoplasm, like the intra-capsular, is originally homogeneous, but it afterwards becomes differentiated in various ways, producing special constituents such as vacuoles, pigment bodies, etc. The following parts may, as a rule, be topographically distinguished: (1) The *Sarcomatrix*, or fundamental layer of protoplasm, which forms a continuous sheath of sarcode round the central capsule, separating it from the calymma; (2) The *Sarcoplegma*, an irregular network of protoplasm, which ramifies through the calymma and forms (3) The *Sarcodictyum*, or network of sarcode, on the outer surface of the calymma, from which (4) The *Pseudopodia* project and radiate into the surrounding water.

The Sarcomatrix.

The sarcomatrix, first described by Haeckel in 1862, forms a thin continuous mucous layer covering the whole external surface of the central capsule, and separating it from the calymma. It communicates with the endoplasm by means of the openings in the capsule membrane. Its thickness varies considerably, even in individuals of the same species, the variation being due partly to the stages of development and partly to nutritional conditions. After an abundance of food the sarcomatrix becomes thickened and turgid, rich in granules and irregular masses, which are probably enclosures of undigested food. Xanthellæ and other foreign bodies taken up with the food, such as diatoms, smaller Radiolaria, infusoria, etc., are often aggregated in considerable numbers in the sarcomatrix. After long fasting, on the other hand, the sarcomatrix becomes destitute of such enclosures and granules. From a physiological standpoint, the sarcomatrix is the most important organ of the extra-capsulum, and is probably the organ of nutrition, especially for purposes of digestion and assimilation. It may also be the organ of perception. The sarcomatrix takes no part in the formation of the skeleton.

The Sarcoplegma.

By the sarcoplegma is understood that portion of the exoplasm which, originating in the sarcomatrix, ramifies in a network in every direction through the substance of the calymma. The

configuration of this protoplasmic network is very variable, and as a rule is very irregular in form, though in some groups it appears to retain a regular shape. In the Spongosphærida and Spongodiscida, which form a spongy cortical skeleton, the protoplasm of the sarcoplegma becomes directly metamorphosed into silex. From a physiological point of view the sarcoplegma is of importance both for the nutrition and motion of the Radiolaria, since it brings the sarcomatrix and the sarcodictyum with its pseudopodia into direct connection.

The Sarcodictyum.

The sarcodictyum is a network of exoplasm forming a reticular covering on the outer surface of the gelatinous calymma. It may be divided into a primary and a secondary sarcodictyum. The original or primary sarcodictyum ramifies over the surface of the primary calymma, and, like this, is of the highest importance in the formation of the primary lattice shell. If we regard the primary calymma as the foundation upon which the lattice shell is deposited, then the primary sarcodictyum furnishes the material from which it is developed. It may be said that the primary lattice shell arises from a direct chemical metamorphosis of the primary sarcodictyum, by a chemical precipitation of the dissolved skeletal material which had been stored up in the exoplasm. Hence the particular form of the primary lattice sphere, with its regular or irregular meshes, is the direct result of a corresponding form of the primary sarcodictyum. The same is true of the secondary sarcodictyum, which ramifies over the external surface of the calymma, and there forms the secondary lattice shells, which retain the configuration of the sarcode from which they have been precipitated.

The Pseudopodia.

The pseudopodia, as a rule, exhibit the same characteristic features of these organs as in other Rhizopods. They are of two kinds, myxopodia and axopodia. The former, which are found in all Radiolaria, are usually long and thin flexible filaments of sarcode radiating freely from the surface of the sarcodictyum into the surrounding water, where they may branch or anastomose to any extent. Granular movement may be observed

in the protoplasm of the myxopodia, which never contain an axial thread.

The axopodia, on the other hand, are highly differentiated pseudopodia, consisting of a firm radial thread or core, with a soft covering of protoplasm. They penetrate the whole calymma in a radial manner, projecting fixedly from its outer surface, and are generally, if not always, produced inwards to the middle of the central capsule, perforating the capsule membrane. They are known only in the second legion, the Acantharia, in which they are widely, if not universally developed. The fine axial thread may be of *acanthin*, the chitinous material of which the Acantharia construct their skeletons. The axopodia are probably sensory organs, and are not retractile, while the myxopodia are.

The Skeleton.

The Radiolaria have long been the delight of microscopists for the regularity and delicacy of their shells, which are developed in a wealth of variety far exceeding other forms of microscopic life. Although the Radiolarian organism always remains an individual cell, it shows the high complexity to which the process of skeleton formation can be brought by a simple cell. Very few Radiolaria are destitute of these skeletons, only ten of the seven hundred and thirty-nine genera described by Haeckel in his *Challenger* monograph being skeletonless. Six of these belong to the first legion, the Spumellaria, and there are two skeletonless genera in the third and fourth legions, the Nassellaria and the Phæodaria. Though numerically insignificant, these skeletonless Radiolaria are of the highest biological interest, as they probably represent the more archaic and ancestral forms from which the whole class has been evolved.

The material of which the skeleton is composed varies in the different legions. The first and third legions, the Spumellaria and Nassellaria, have shells of pure silica. The second legion, the Acantharia, use a peculiar organic substance, allied in its composition to chitin, called *acanthin*; while the fourth legion, the Phæodaria (except one family, the Dictyochida), have skeletons of an organic compound, which is apparently a silicate of carbon. There are no Radiolaria with calcareous skeletons.

The acanthin, of which the Acantharia build their skeletons, is very easily destroyed, being soluble in both acids and alkalis, and also in sea-water. The skeletons of this legion are therefore practically known only from such specimens as have been observed in the living state, being of very rare occurrence in the Radiolarian oozes now forming in the deep sea, and absolutely unknown in the fossil state.

The carbonic silicate, of which the Phæodaria build their skeletons, is less easily destroyed than acanthin, but it is strongly acted upon by heat, and also by alkalis, though proof against acids. It offers greater resistance to the solvent power of sea-water than acanthin, and hence skeletons of the Phæodaria may be found sparingly in deep-sea deposits. In the fossil state the legion is represented by one family only, the Dictyochida, the members of which are characterised by the possession of a purely siliceous skeleton.

The pure siliceous skeletons of the Spumellaria and Nassellaria, which were first recognised and described by Ehrenberg in 1838, are practically indestructible, and hence occur in fossil deposits of all ages, and in enormous numbers in the deep-sea Radiolarian oozes. It should be borne in mind that Ehrenberg's name for the class, "Polycystina," is only applicable to these two legions, as, with the exception of the Dictyochida, which he regarded as diatoms, Ehrenberg had no knowledge of the Acantharia or Phæodaria.

The skeletons of the Radiolaria are characterised by great strength and firmness, the acanthin skeleton of the Acantharia being only slightly inferior in stiffness to the siliceous skeletons of the Polycistina. The silicate shells of the Phæodaria, which in many cases have skeleton tubes filled with a gelatinous material, are much weaker, and sometimes are extremely brittle.

In the second legion, the Acantharia, the skeleton is *centrogenous*—that is to say, the formation of the skeleton begins in the middle of the central capsule, from which point twenty (the normal number) radial spines of acanthin are centrifugally developed. The three other legions, on the other hand, possess *perigenous* skeletons—that is to say, the skeleton originally develops outside the central capsule. In the Nassellaria and Phæodaria the skeleton remains outside the central capsule, as also in a part of the Spumellaria; but in the greater part of this

legion the central capsule in its growth more or less envelopes the primary perigenous skeleton, which then lies partially within it.

Haeckel recognises twelve different types of skeleton formation, some peculiar to a single legion or even part of a legion, while others occur in several legions. The descriptions of these types and their distribution in the legions are too technical for introduction here.

The skeletons of most Radiolaria are armed with radial spines, which are of importance both morphologically and physiologically. Their number and arrangement are a determining factor as regards the general form of the skeleton, and they also discharge the functions of organs of protection and support.

Life History.

Owing to the difficulty of direct observation, the life history of the Radiolaria is incompletely known. From what has been actually observed, coupled with deductions from observations made in respect to their nearest allies, the Heliozoa, the life history would appear to be somewhat of this nature. After maturation, the nucleus of the central capsule breaks up into a great number of small nuclei, each of which becomes a zoospore by surrounding itself with a small particle of the endoplasm; it generally absorbs one or several fat granules, and sometimes a small crystal. Each of these zoospores is furnished with one or more long vibratile flagella, and commences its movements while still enclosed in the central capsule. The extra-capsulum takes no part in the development of the species. Presently the central capsule ruptures and the spores escape, the parent Radiolarian then dying. The zoospores, which at this stage of the life history resemble a flagellate infusorian of the simplest class, such as Astasia, are ovoid or subcylindrical, averaging ·005 mm. in diameter, and swim freely by means of their flagella.

All attempts to cultivate these zoospores have failed, and a wide gap ensues between the swarm spore and Actissa, the simplest Radiolarian adult form known. This gap can only be bridged by assuming that the young Radiolarian passes through several Heliozoon-stages, following one on another. Thus from analogy with the Heliozoa it may be assumed that after swimming freely

for some time the zoospore comes to rest and passes into what we may call the Actinophrys stage. It probably assumes by contraction a spherical shape, loses its flagellum, and develops radial pseudopodia all over its surface, the nucleus assuming a central position. In this condition it would practically be an Actinophrys.

The Actinophrys stage is probably connected with Actissa by an intermediate form, which may be regarded as a simple skeletonless Heliozoon with a "jelly-veil," such as *Sphærastrum* (in the solitary condition) and *Heterophrys*. The young Radiolarian in this second or Sphærastrum stage becomes a simple cell with pseudopodia radiating on all sides. Its body consists of three concentric spheres—the central nucleus, the protoplasmic body proper, and the surrounding calymma or jelly-veil.

The formation of a firm membrane, the capsule membrane, between the sarcode body and the jelly-veil completes the transformation from a Sphærastrum to a true Radiolarian in its simplest form, Actissa. Thus arises the central capsule, the characteristic feature of the Radiolaria, which is wanting in their nearest allies, the Heliozoa. Actissa is not only the simplest Radiolarian known to us, but is also probably the true prototype of the whole class, as it is the simplest form under which the Radiolarian organism can be conceived.

Although reproduction by spore formation is probably the normal habit with all Radiolaria, there are certain families, notably the social Spumellaria (Polycyttaria), in which the organism increases by spontaneous cell division. The central nucleus separates (by direct nuclear division) into two halves, the central capsule follows suit, becoming constricted between the two nuclei, each of which finally becomes enclosed in one of the two new capsules. As this process does not involve the extra-capsulum at all, we arrive eventually at a stage in which a number of sister cells, which have arisen by repeated division of the parent nucleus and capsule, are enclosed in a common rapidly-growing calymma, forming a true cœnobium or colony.

Reproduction by gemmation or budding has been observed in the Radiolaria, but so far only in the social Radiolarians (Polycyttaria), where it appears to be widely distributed. The gemmules or capsular buds are developed on the surface of young central capsules which have not yet secreted a membrane. After

reaching a certain size the buds become separated from the parent capsule, and are distributed through the sarcoplegma by the currents of the exoplasm. Here each bud develops into a complete central capsule by the formation of a capsular membrane.

It has been observed by Hertwig and Karl Brandt that certain of the social Radiolaria form two distinct kinds of spores, which have been called isospores and anisospores. The isospores are the same asexual zoospores as have been observed in many Radiolaria, but the anisospores, which are in two forms, female macrospores and male microspores, are sexually differentiated, and probably conjugate after their exit from the central capsule, thus producing a new cell. As the same colony has been observed to produce the sexual and asexual spores at different times, it is probable that they alternate, and that we have here a true instance of Alternation of Generations.

The digestive and nutritive functions of the Radiolaria are purely animal, and like all other animals they are compelled to obtain their nutriment in a ready formed condition, having no power to form it synthetically after the manner of plants. The oxygen may be derived either from the surrounding water or from the symbiotic xanthellæ, which under the action of direct sunlight evolve large quantities of oxygen.

These xanthellæ have already been mentioned as frequent, but not invariable, enclosures in the Radiolarian body; and as they play a most important part in the functions of the animal, and are also of the highest interest to the biologist, they call for a detailed description.

The xanthellæ, or "yellow cells," of the Radiolaria were first discovered by Huxley, who described them in 1851 in certain species of Collodaria, the family in which they are now known to occur most abundantly. In 1858 J. Müller described their occurrence in the extra-capsular protoplasm of many Spumellaria and Nassellaria, and also within the central capsule of certain Acantharia. Haeckel, in 1862, gave a detailed description of their structure and increase by division, proving that they were true cells. At this time, and for several years subsequently, the xanthellæ were believed to be integral parts of the Radiolarian organism, and hence the Radiolaria were considered to be unquestionably multicellular animals. In 1870 Haeckel proved

that these yellow cells invariably contained starch, a vegetable product thus apparently arising from an animal source.

In 1871 Cienkowski published the result of some remarkable observations which explained this seeming discrepancy, the formation of starch by an animal organism, and at the same time destroyed the theory of the multicellular structure of the Radiolaria. He showed that the yellow cells did not perish at the death of the Radiolarian body, but that they continued to flourish, dividing and increasing uninterruptedly. From this fact, coupled with their undoubted cellular nature, he came to the conclusion that they were not integral parts of the Radiolarian organism, but independent unicellular Algæ living parasitically in the body of the Radiolarian.

In 1881 and 1882 Brandt and Geddes published almost simultaneously the result of further investigations, which proved the accuracy of Cienkowski's theory of their vegetable origin. Brandt found that the yellow cells could survive for some months after the Radiolarian's death, and described them as unicellular algæ under the name of Zooxanthella, comparing their relations with the Radiolarian organism to the symbiosis between the algoid gonidia and the fungoid hyphæ in the Lichens, which had been recently discovered by Schwendener. Brandt also succeeded in removing the xanthellæ from living Radiolaria, and in cultivating them artificially. He then successfully implanted them in the body of a fresh host. Geddes also described the yellow cells as unicellular algæ, under the name of Philozoon, and proved by experiment that they give out oxygen under the action of sunlight. Thus, if two Radiolarian colonies of equal size be placed in equal quantities of filtered sea-water in sealed tubes, and one tube be exposed to light while the other is kept in the dark, the latter perishes almost at once, while the former thrives for a long time, the yellow cells absorbing the carbon dioxide expired by the animal and furnishing in return under the stimulus of sunlight sufficient oxygen for the animal's respiration.

There is, therefore, no longer room for doubt that the xanthellæ are not integral parts of the Radiolarian animal, but separate organisms of vegetable nature, either penetrating actively into the Radiolarian from without, or absorbed passively by means of the pseudopodia. This commensal life must be of advantage for both the symbiontes, for the animal Radiolarian cell furnishes

the inquiline xanthellæ with shelter and protection as well as with carbon dioxide for nutriment, while the vegetable cells yield their host oxygen for respiration, and after their death the starch and protoplasm which they have formed, for nutriment. This symbiosis has been compared with the commensal life of the Lichens, in which algoid gonidia, organisms with a vegetable metastasis, and fungoid hyphæ, organisms with an animal metastasis, are conjoined for mutual advantage. But the comparison can be pushed too far, for while in the Lichens this symbiosis is essential for the development of the organism, in the Radiolaria it has more the appearance of an adventitious association. The xanthellæ vary so much in number, even in the same species, that they cannot be essential to its existence, and in a great many species they have never been seen. Again, many Radiolaria, notably the Phæodaria, live only at considerable depths in absolute darkness; and in these the xanthellæ, even if present, could not give off oxygen owing to the absence of light. Still it is possible that the phæodellæ of the Phæodaria (usually green, olive, or brown in colour), which are true cells, are vegetable symbiontes which, in the absence of sunlight, are able to evolve oxygen under the influence of the phosphorescence of abyssal animals.

The xanthellæ are usually spherical or elliptical, sometimes discoidal. They occur in varying numbers in the extra-capsular bodies of many Radiolaria of the first and third legions, the Spumellaria and the Nassellaria, most abundantly in the sub-legion Collodaria. They have been proved to contain starch or an amyloid substance. Their envelope contains cellulose, and their characteristic yellow colour is due to pigment grains of a similar nature to the colouring matter of diatoms. They multiply by fission within the cell membrane, each cell giving origin to four, which then escape. They are also capable of assuming an encysted and also an amœboid condition. They may be distinct forms of Algæ, but possibly are only swarm-spores of larger Algæ, especially Fucaceæ. The size of the extra-capsular xanthellæ is usually between ·008 mm. and ·012 mm.

While the xanthellæ of the first and third legions are confined to the extra-capsulum, in the second legion, the Acantharia, they are never found except in the central capsule. Their number is variable, but rarely exceeds thirty, and they lie as a rule close

to the capsule membrane. In shape they agree with the extra-capsular xanthellæ; but their size is greater, averaging ·01 to ·03 mm. They are probably a distinct species of Alga.

The Radiolaria have other sources of nutriment besides the xanthellæ and their by-products, for the amount of food extracted from the surrounding water by means of their pseudo-podia must be large. Diatoms, infusoria, foraminifera, and particles of decaying animal and vegetable matter, are seized by the pseudopodia and conveyed to the sarcodictyum and thence to the sarcomatrix, there to be assimilated. The insoluble portions, such as the diatom valves and calcareous shells of foraminifera, are often to be found here in large numbers. They are eventually removed by the streaming of the sarcode.

Currents in the sarcode body, commonly known as streaming of the protoplasm, are continuous throughout the life of the Radiolaria. They are, as a rule, only visible owing to the motion thereby imparted to solid particles of matter imbedded in the sarcode, but sometimes the plasma itself may be seen to circulate. The currents are only visible under exceptional circumstances within the central capsule, although we may presume that the sarcode here is also in continual motion. They may be readily observed in the pseudopodia, and can be followed through the sarcodictyum and sarcoplegma to the sarcomatrix, and thence occasionally through the openings in the capsule membrane to the central capsule. The flow of the current is radial in direction, and sometimes the same pseudopodial thread shows reverse currents on its opposite sides. The rapidity of the currents varies greatly. They must be of great importance in the economy of the animal, not only for the inception of food and dispersal of waste products, but also for locomotion and perception.

The powers of motion in the mature Radiolarian, as opposed to the free-swimming zoospore, are very limited. It is practically certain that they float freely suspended in the water either near the surface or at definite zones of depth. This is due to the equilibrium existing between the organism and the surrounding water. The increase of specific gravity due to the formation of the skeleton is counterbalanced by the secretion of oil and fat globules, and perhaps also by the formation of alveoles in the sarcode. The radial spines and the pseudopodia radiating in all

directions would also tend to act against gravity by increasing the frictional resistance.

Radiolaria are able to creep slowly along the surface of any solid body with which they may be in contact by contraction of the pseudopodia, but this means of locomotion can only be of service when they are in actual contact with the sea bottom, which probably is of rare occurrence during life. Beyond this their power of motion seems to be limited to rising or sinking vertically in the water. This is probably managed by means of contraction or expansion of the calymma by osmosis, which would affect the specific gravity of the organism. It is also possible that the protrusion or retraction of the pseudopodia may effect the same result. Brandt considers that the sinking and rising of the Radiolaria are associated with the disappearance and reappearance of vacuoles.

Phosphorescence is widely distributed among the Radiolaria. They emit a greenish or yellowish light, which appears to radiate from the fat globules within the central capsule, and is probably due to the slow oxidation of the fat globules. It doubtless serves as a warning light for the protection of the Radiolaria, as phosphorescent animals are generally armed with spines, stinging cells or other defensive weapons.

The Radiolaria have no specially differentiated sense organs, although the pseudopodia perhaps act as organs of sensation as well as of motion. They have been proved to be sensitive to the stimuli of pressure, temperature, light, and variations in the chemical composition of the water in which they are suspended.

Distribution.

The Radiolaria are wholly marine, and have a world-wide distribution, from the Equator to the highest latitudes yet reached. In many parts of the world they occur in astonishingly large masses, both on the surface, in different zones of depth, and near the bottom. They must play a most important part in the economy of marine life, especially as food for other animals. As with other forms of life, the greatest development of species occurs in the tropics, while in high latitudes we find relatively few species, but these occurring in prodigious numbers. This

great abundance of forms in the tropics cannot be due entirely to the increase of temperature, for quite half of the Radiolaria live normally at abyssal depths where the temperature remains constantly just above the freezing point. The more favourable conditions of life produced by the large supply of food obtainable from the decaying animal and vegetable matter suspended in the water, is probably answerable for the richness of the Radiolarian fauna in the tropics.

Having no power of horizontal motion, the Radiolaria are entirely at the mercy of oceanic currents. Such currents occur not only at the surface, but also at all depths of the sea, and as a result we find that a great many Radiolaria, probably the majority, have a very wide range of distribution. A large number of species are practically cosmopolitan, being found in all the great oceans. The class reaches its greatest development in the Pacific, both as regards variety of species and individual numbers. The only extensive areas of Radiolarian ooze known occur in the deepest portions of the central and northern Pacific, and the dead shells form a considerable proportion of the calcareous oozes and red clays from the shallower areas of this ocean.

The Radiolaria do not appear to be confined to the surface water, as was at one time believed, for the researches of the *Challenger* and other expeditions have proved the existence of a distinctly abyssal Radiolarian fauna, connected with the pelagic species by intermediate zones of life. It seems probable that young individuals inhabit deeper water than the adult form.

The pelagic Radiolaria float normally at or near the surface, and probably never descend below thirty fathoms. At a certain distance from the shore the surface of the ocean appears to swarm with living Radiolaria. In the tropics the crowd consists of many different species, but in colder seas, the individuals, though equally numerous, present less variety. The great bulk of these pelagic Radiolaria belong to the first and second legions, the Porulosa. There are very few pelagic Osculosa, and these belong principally to the third legion, the Nassellaria, as the fourth Legion, the Phæodaria, have very few representatives among the pelagic forms. Pelagic Radiolaria may usually be distinguished by the more delicate and slender structure of their skeletons. The pores of the lattice shells are larger and the

cross-bars of the network thinner. The armature of spines is also more varied and developed. Many pelagic Radiolaria have either an incomplete skeleton or none at all.

More than half of all the Radiolaria known belong to the abyssal fauna, from depths between 2000 and 4000 fathoms. They live constantly at this depth, floating at a little distance above the sea bottom, and have evidently become specially adapted to the extraordinary conditions of their existence—utter darkness except for such light as may proceed from their own phosphorescence or that of other deep-sea animals, accompanied by a constant temperature but slightly above the freezing point, and tremendous pressure. Probably as a result of these conditions of life, they present certain structural features by which they may be distinguished from the pelagic and zonarial forms, whose skeletons also occur in prodigious numbers in deep-sea deposits. The lattice-work of the shells is coarser and thicker and the pores smaller than in pelagic species of the same group, while the armature of spines is less highly developed, and the whole skeleton smaller and more massive. Nearly all the fourth legion, the Phæodaria, belong to the abyssal fauna, which also includes many of the third legion, the Nassellaria, while, on the other hand, the first and second legions are but sparingly represented.

By the use of tow-nets, lowered to different depths at the same station, it has been proved that the water intermediate between the surface and the bottom is inhabited by zones of Radiolarian life which present characteristic differences at various depths. They may be compared to the zones of vegetation on the sides of a mountain range. From the comparatively few data available Haeckel has provisionally distinguished five zones :—

(1) The *pelagic* zone, from the surface to about 25 fathoms.

(2) The *pellucid* zone, from 25 to 150 fathoms, the greatest depth at which sunlight makes its influence felt.

(3) The *obscure* zone, from 150 to 2000 fathoms; from the depth at which sunlight vanishes, to that at which calcareous organisms begin to disappear, owing to the solvent action of the carbonic acid in solution.

(4) The *siliceous* zone, from 2000 or 2500 to 3000 fathoms, in which only siliceous rhizopods are found, and in which the peculiar influences of the lowest depths have not yet appeared.

(5) The *abyssal* zone, in which the accumulation of oceanic deposits and the influence of bottom currents create new conditions of existence.

Speaking generally, the first and second zones consist mainly of the Porulosa, while as the depth increases these disappear and are replaced by the Osculosa. The obscure zone is the poorest in species. The morphological characters of the zonarial fauna appear to change gradually upwards into the delicate pelagic forms, and downwards into the robust abyssal, while the average size (within the limits of the same family) increases as we go upwards, and decreases downwards.

We have already seen that the skeletons of the second legion, the Acantharia, owing to their solubility, do not occur in bottom deposits, while the carbon silicate skeletons of the Phæodaria, which are more refractory, are sparingly represented. The purely siliceous skeletons of the Spumellaria and Nassellaria are, however, almost indestructible, and sink to the bottom after the death of the animal. They must be constantly falling in a gentle rain on the sea bottom at all depths beyond the influence of terrigenous deposits, say 100 to 200 miles from the coast line; but owing to their minute size as compared with the calcareous shells of the Foraminifera and other pelagic animals, they are more or less masked in all oceanic deposits of depths under 2000 fathoms, although their presence may nearly always be detected in varying quantities by the removal of the calcareous organisms. The Globigerina oozes, which cover the greater portion of the ocean bottom between 250 and 2500 fathoms, contain a large though varying number of Radiolarian skeletons.

Below 2000 fathoms the solvent action of carbonic acid in solution quickly dissolves the calcareous organisms, and Globigerina oozes gradually disappear, to be replaced by the Red Clay, which covers an enormous area of the ocean bed. The Red Clay is principally composed of silicate of alumina, derived from the decomposition of volcanic ash, pumice, etc. It contains very few calcareous organisms, but Radiolarian remains are frequent, and in some cases so abundant that the Red Clay passes gradually into a true Radiolarian ooze (*e.g.*, *Challenger* stations 238 to 253 in the North Pacific).

In certain limited areas of the Pacific and Indian Oceans, at depths of from 2000 to 4500 fathoms, the bottom ooze contains

such large numbers of Radiolarian skeletons (as much as 75 per cent. in some cases), that the deposit may be termed a pure Radiolarian ooze. At present no such deposit is known in the Atlantic Ocean. In the natural state Radiolarian ooze is yellowish or brown in colour, from the admixture of minerals which it contains, but when decalcified it appears as a fine white powder.

Radiolaria, or, more correctly, Polycystina, have been found in the fossil state in sedimentary deposits of all ages from the Silurian and Cambrian to the present time. The great majority of the fossil Radiolaria, which all belong to the two legions Spumellaria and Nassellaria, are derived from Tertiary strata. The richest and most important of these deposits are of Miocene age, the best known being those of Barbados, Sicily, and the Nicobar Islands, all of which may be regarded as pure Radiolarian oozes in a fossil condition. Besides these pure Radiolarian oozes, there are many other deposits known especially in the south of Europe and north of Africa, in which Radiolaria exist in considerable numbers, mixed with other organisms.

A considerable number of Radiolaria are known from strata of the secondary period, principally from rocks and coprolites of Jurassic age, but a few also from the Chalk and Trias. A few species have also been described from various rocks of Primary age, ranging back from the Permian and Carboniferous to the Devonian, Silurian, and Cambrian. These palæozoic Radiolaria are all of an extremely simple and primitive structure, mostly simple Spumellaria.

The best known and most typical of all the fossil Radiolarian deposits are those of the Island of Barbados, which have been studied in great detail by many observers, both geologists and microscopists. Practically the whole island, which rises to a height of 1147 feet and includes nearly 16,000 acres, is composed of various deep-sea deposits, such as globigerina oozes, clays, and pure Radiolarian oozes. Some of the latter contain as much as 70 per cent. by volume of Radiolarian skeletons. Haeckel estimates the number of species in the Barbados deposits at nearly five hundred, of which about 25 per cent. are living at the present time.

Our knowledge of the Radiolaria has grown very rapidly since 1834, when the first Radiolarian was described by Meyer.

Ehrenberg, Müller, Haeckel and Hertwig were the principal early workers in the field, and, up to 1887, 810 various forms had been described by them and others. In 1887 Haeckel published the result of his ten years' labour at the material collected by the *Challenger* Expedition, adding no less than 3508 new species to those previously known, and making a total of 739 genera and 4318 species. Prodigious as this number may appear, the distinguished author expresses an opinion that it is by no means exhaustive, and that "a careful and patient worker who would devote a second decade to the work would probably increase the number of new forms (especially of the smaller ones) by more than a thousand; but for a really complete examination, the lifetime of one man would not suffice."

Explanation of the Plates.

The figures have all been reproduced, by kind permission of Sir John Murray, K.C.B., from the Report on the Radiolaria of the *Challenger* Expedition; and I should like to express my thanks to my friend Mr. A. J. French, a member of the Club, for the care which he has displayed in their reproduction. The letters have the same meaning in all the figures.

[*a* = central capsule. *aa* = extensions or apophyses of the central capsule. *as* = astropyle. *c* = calymma. *n* = nucleus. *nu* = nucleoli. *v* = vacuoles. *al* = alveoles. *o* = oil globules. *x* = xanthellæ. *r sp* = radial spines of centrogenous skeleton. *ps* = pseudopodia. *p* = podoconus. *ph* = phæodium. *phph* = phæodellæ. *pr* = proboscis. *sl* = skeleton. *pp* = lateral parapylæ.]

Plate 15.

Fig. 1. A Radiolarian of the First Legion (Spumellaria), *Cladococcus abietinus*, Haeckel. A portion of the calymma, etc., has been removed to show the surface of the lattice sphere, through the pores of which the central capsule, which was originally entirely enclosed, has thrust out numerous club-shaped extensions or apophyses. The central spherical nucleus fills about half the shell cavity. × 160 diameters.

Fig. 1A. Central capsule of *Thalassoplancta brevispicula*, Haeckel, a Radiolarian of the First Legion (Spumellaria).

The central nucleus includes many nucleoli. The sarcode is divided up into innumerable clear vacuoles, and in the cortical zone and close to the capsule membrane there is a layer of large oil globules. The alveolate calymma is shown in the lower half of the figure. × 50 diameters.

Fig. 2. A Radiolarian of the Second Legion (Acantharia), *Lithoptera quadrata*, Haeckel. In the Second Legion the skeleton is centrogenous, and in the figure the central part of the skeleton can be seen enveloped in the four-lobed central capsule. × 150 diameters.

Fig. 2A. Equatorial section through the central capsule of *Zonaspis cingulata*, Haeckel, a Radiolarian of the Second Legion (Acantharia), showing the spines of the centrogenous skeleton radiating from its centre, and the intra-capsular xanthellæ peculiar to this legion. × 205 diameters.

Plate 16.

Fig. 3. A Radiolarian of the Third Legion (Nassellaria), *Cyrtocalpis urceolus*, Haeckel. The siliceous skeleton encloses an ovate central capsule, which exhibits at the basal pole the striated podoconus, and in the upper half a large spherical nucleus and oil globules. Between the capsule membrane and the skeleton are many xanthellæ, some of which have been extended through the shell mouth along the radiating pseudopodia. × 265 diameters.

Fig. 3A. Central capsule of *Tripterocalpis ogmoptera*, Haeckel, a Radiolarian of the Third Legion (Nassellaria), showing in the centre the podoconus, a feature peculiar to this legion. On its right is the large kidney-shaped nucleus, and above it are several oil globules. × 160 diameters.

Fig. 4. A Radiolarian of the Fourth Legion (Phæodaria), *Challengeria murrayi*, Haeckel, seen from the dorsal side. The oral portion of the skeleton shows the hexagonal "diatomaceous" markings characteristic of the Family Challengerida. In the

lower half of the shell is situated the central capsule, which exhibits the characteristic astropyle and proboscis. Streams of sarcode arise from the central capsule and pierce the calymma inside the shell. There are no lateral parapylæ in this Family. × 27 diameters.

Fig. 4A. Central capsule of *Aulospathis bifurca*, Haeckel, a Radiolarian of the Fourth Legion (Phæodaria), surrounded by the Phæodium, which has been partly removed. The central capsule has the double membrane characteristic of the legion, and contains a large nucleus with many nucleoli. The intracapsular protoplasm contains many vacuoles. At the bottom is the radiate operculum of the astropyle; at the top are the two lateral parapylæ. × 53 diameters.

A List of the fossil Radiolaria from Barbados, figured in Ehrenberg's "Fortsetzung der mikrogeologischen Studien,"* with the equivalent names used by Haeckel.

By Arthur Earland.

(Taken as read, November 17th, 1899.)

When Haeckel published in 1887 his monograph on the *Challenger* Radiolaria, he incorporated in the text descriptions of all the species of Radiolaria then known, in most instances transferring them to new genera of his own creation. As Haeckel's work must always remain the standard work of reference on the subject, it has been thought that the following list, which was drawn up for private purposes, may prove useful to microscopists. The names in the left-hand column are Ehrenberg's; on the right are those under which Haeckel describes the forms, the figures referring to the pages of the *Challenger* Report.

Plate 1.

Only one figure on this plate can be identified with certainty as a Radiolarian—viz. fig. 29.

Foraminifera.

FIG.
1. Planulina mica.
2. Rotalia (?) (barbadensis).

* "Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersicht der mikroskopischen Paläontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rücksicht auf den Polycystinen-Mergel von Barbados: von C. G. Ehrenberg. Aus den Abhandlungen der Königl. Akademie der Wissenschaften zu Berlin 1875. Mit xxx Tafeln. Berlin, 1875."

For a prolonged loan of this valuable work on the fossil Radiolaria of Barbados I am indebted to my friend Mr. D. Bryce Scott.

I may add that photographs of the thirty plates above referred to have been prepared. Any communications as to the supply of copies should be addressed to me at 28, Glenwood Road, Catford, S.E.—[A. E.]

Diatoms.

FIG.

3. Dictyolampra stella.
4. Actinogonium septenarium.
5, 6. Liostephania magnifica.
7, 8. " comta.
9–11. " rotula.
12–15. Hemiaulus polycistinorum.
16. Triceratium microporum.

Sponges.

17. Actinolithis hexaclados.		
18. " tornata.		
19. " trifida.		
20. " apiculata.		
21. " neptunia.		
22. Rhabdolithis umbraculum.		
23. " serra.		
24. " tortuosum.		
25. " sceptrum.		
26. " ingens.		
27. " pipa.		
28. " fungillus.		
29. Stephanolithis spinescens	. Semantis spinescens. *Haeckel*	958
30, 31. " annularis.		
32. " nodosa.		
33. Placolithis ocellata.		

Plate 2.

1. Cornutella scalaris .	. Sethopyramis scalaris. *H.* .	1253
2. " quadratella .	. " quadratella. *H.* .	1254
3. " stiligera . .	. Cornutella stiligera. *Ehr.* .	1181
4. " circularis .	. " circularis. *Ehr.* .	1181
5. " ampliata .	. Sethoconus ampliatus. *H.* .	1291
6. " spiniceps .	(?) Lophophæna galea. *Ehr.* .	1303
7. " cucullaris .	. Sethoconus cucullaris. *H.* .	1290
8. " mitra . .	. { Cornutella mitra. *Ehr.* .	1181
	or Sethoconus mitra. *H.* . .	1291
9. " clathrata .	. { Cornutella clathrata. *Ehr.* .	1182
	or Sethoconus clathratus. *H.* .	1295
10. Halicalyptra galea . .	. Tripocalpis galea. *H.* . .	1136
11. " fimbriata .	. Clathrocyclas fimbriata. *H.* .	1386
12. " setosa . .	. Carpocanium setosum. *H.* .	1280

Plate 3.

1. Cenosphæra megapora .	(?) Staurosphæra apostolorum. *H.*	155
2. " micropora .	(?) " .	"
3. " spinulosa .	(?)	

FIG.			
4.	Lithopera lagena . .	Sethocapsa lagena. *H.* .	1310
		or Sethopera lagena. *H.* . .	1233
5.	„ amblyostauros	(?) Sethocapsa staurocephala. *H.*	1311
6.	„ oxystauros .	(?) „ „	„
7.	„ nidus pendulus .	Sethocapsa nidus. *H.* . .	1311
8.	Lithomelissa macroptera .	Lithomelissa ehrenbergii. *Büt.*	1204
9, 10.	„ „ . .	„ macroptera. *Ehr.*	1204
11.	„ ventricosa . .	Micromelissa ventricosa. *H.* .	1236
12.	„ corythium . .	Lithomelissa corythium. *Ehr.*	1207
13.	„ microptera . .	Micromelissa microptera. *H.* .	1236
14.	„ capito . . .	Peromelissa capito. *H.* . .	1237
15.	Lithobotrys adspersa . .	Botryocella nucula. *H.* . .	1116
16.	„ nucula . . .	„ „ . *H.* .	„
17.	„ stiligera . .	Patagospyris stiligera. *H.* .	1088
18.	„ ornata . . .	Lithobotrys ornata. *Ehr.* .	1118
19.	„ geminata . .	„ geminata. *Ehr.* .	1118
20.	„ (?) cribrosa . .	Botryopyle cribrosa, *H.* . .	1113
21.	„ nasuta . . .	Lithobotrys nasuta. *Ehr.* .	1118

PLATE 4.

1.	Lithocampe (?) ampullacea .	Theoconus ampullaceus. *H.* .	1402
2.	„ (?) clava . .	Lithocampe clava. *Ehr.* . .	1507
3, 4.	Lithocorythium oxylophos .	Lithobotrys lithocorythium. *H.*	1118
5.	„ platylophos	„ geminata. *Ehr.* .	1118
6.	„ cephalodes .	Botryopyle cephalodes. *H.* .	1113
7.	Lithornithium foveolatum .	Lithornithium foveolatum. *Ehr.*	1355
8.	„ loxia . .	Artopera loxia. *H.*	1452
9.	„ luscinia . .	Theopera luscinia. *H.* . .	1358
10.	Lithochytris vespertilio . .	Lithochytris vespertilio. *Ehr.*	1365
11.	„ tripodium . .	„ tripodium. *Ehr.*	1363

PLATE 5.

1.	Lithochytris pyramidalis .	Lithochytris pyramidalis. *Ehr.*	1364
2.	„ barbadensis .	Sethochytris barbadensis. *H.* .	1239
3.	„ pileata . .	Lithochytris pileata. *Ehr.* .	1363
4, 5.	Dictyophimus craticula .	Dictyophimus craticula. *Ehr.* .	1196
6.	„ pocillum .	„ pocillum. *Ehr.* .	1200
7.	Carpocanium coronatum . .	Carpocanium coronatum. *Ehr.*	1284
8.	Cryptoprora ornata . . .	Alacorys ornata. *H.* . .	1375

PLATE 6.

1.	Anthocyrtis leptostyla . .	Anthocyrtium leptostylum. *H.*	1275
2.	„ furcata . .	Anthocyrtis furcata. *Ehr.* .	1269
3.	„ ficus . . .	Anthocyrtium ficus. *H.* . .	1277
4.	„ mespilus . .	Anthocyrtis mespilus. *Ehr.* .	1269
5.	„ „ . .	Anthocyrtium centaurea. *H.* .	1273

FIG.				
6.	Anthocyrtis grossularia	Anthocyrtis grossularia.	*Ehr.*	1271
7.	„ serrulata	Anthocyrtoma serrulata.	*H.*	1268
8.	„ collaris	Anthocyrtium collare.	*H.*	1273

PLATE 7.

1.	Lychnocanium tribulus	Lychnocanium tribulus.	*Ehr.*	1226
2.	„ tripodium	„ tripodium.	*Ehr.*	1229
3.	„ tetrapodium (?)	„ sigmopodium.	*H.*	1228
4.	„ tridentatum	Dictyophimus tridentatus.	*H.*	1199
5.	„ trichopus	Lychnocanium trichopus.	*Ehr.*	1228
6.	„ turgidum	Pterocorys turgida.	*H.*	1319
7.	„ crassipes	Lychnocanium crassipes.	*Ehr.*	1230
8.	„ hirundo	„ hirundo.	*Ehr.*	1227
9.	„ hamosum	Dictyophimus hamosus.	*H.*	1199
10.	„ cypselus	Lychnocanium cypselus.	*Ehr.*	1229
11.	„ continuum	„ continuum.	*Ehr*	1225
12.	„ ventricosum	„ ventricosum.	*Ehr.*	1226

PLATE 8.

1.	Anthocyrtis ventricosa	Anthocyrtis ventricosa.	*Ehr.*	1270
2.	„ hispida	Anthocyrtium hispidum.	*H.*	1275
3.	Lychnocanium lucerna	Dictyophimus lucerna.	*H.*	1199
4.	„ falciferum	Lychnocanium falciferum.	*Ehr.*	1227
5.	„ carinatum	„ carinatum.	*Ehr.*	1226
6.	Lophophæna capito	(?) Lithomelissa Ehrenbergii.	*Büt.*	1204
7, 8.	„ radians	Lophophæna circumtexta.	*H.*	1304
9.	„ „	„ radians.	*Ehr.*	1303
10.	„ larvata	Sethoconus larvatus.	*H.*	1292
11.	„ apiculata	Lophophæna galea.	*Ehr.*	1303
12.	„ galeata	(?) Lithomelissa Ehrenbergii.	*Büt.*	1204
13.	„ lynx	(?) Lophophæna radians.	*Ehr.*	1303
14.	Eucyrtidium stephanophorum	Lophocyrtis stephanophora.	*H.*	1410
15.	„ asperum	Theocyrtis aspera.	*H.*	1408
16.	„ sphærophilum	Theocorys sphærophila.	*H.*	1418

PLATE 9.

1.	Eucyrtidium argus	Lithostrobus argus.	*Büt.*	1472
2.	„ sipho	Eusyringium sipho.	*H.*	1497
3.	„ fistuligerum	„ fistuligerum.	*H.*	1498
4.	„ alauda	Theocorys alauda.	*H.*	1418
5.	„ scolopax	„ scolopax.	*H.*	1416
6.	„ tubulus	Theosyringium tubulus.	*H.*	1410
7.	„ barbadense	Theocyrtis barbadensis.	*H.*	1406
8.	„ acanthocephalum	Lophocorys acanthocephala.	*H.*	1421
9.	„ (?) nassa	Sethoconus nassa.	*H.*	1293
10.	„ armadillo	Sethocorys armadillo.	*H.*	1302
11.	„ montiparum	Eucyrtidium montiparum.	*Ehr.*	1493

Plate 10.

FIG.				
1.	Eucyrtidium	cylindricum	Theocyrtis cylindrica. *H.*	1406
2.	,,	excellens	Dictyocephalus excellens. *H.*	1306
3.	,,	Mongolfieri	Sethamphora Mongolfieri. *H.*	1251
4.	,,	cancrinum	Sethocyrtis cancrina. *H.*	1299
5.	,,	embolum	Phormocyrtis embolum. *H.*	1369
6.	,,	gemmatum	Theocampe gemmata. *H.*	1425
7, 8.	,,	biauritum	Lophocyrtis biaurita. *H.*	1411
9.	,,	coronatum	,, coronata. *H.*	1411
10.	,,	apiculatum	Lophoconus apiculatus. *H.*	1404
11, 12.	,,	ampulla	Sethamphora ampulla. *H.*	1251
13.	,,	eruca	Eucyrtidium eruca. *Ehr.*	1493
14.	,,	pirum	Theocampe pirum. *H.*	1423

Plate 11.

1.	Eucyrtidium	picus	Lithostrobus picus. *Büt.*	1472
2, 3.	,,	articulatum	Dictyomitra articulata. *H.*	1476
4.	,,	crassiceps	Dictyocephalus crassiceps. *H.*	1306
5.	,,	acephalum	Lithomitra acephala. *Büt.*	1485
6.	,,	pusillum	(?) Theocyrtis elegans. *H.*	1406
7.	,,	bicorne	Lophocorys bicornis. *H.*	1421
8.	,,	Hillaby	Theocyrtis microtheca. *H.*	1407
9.	,,	lineatum	Lithomitra lineata. *H.*	1484
10.	,,	microtheca	Theocyrtis microtheca. *H.*	1407
11.	,,	cryptocephalum	Theocampe cryptocephala. *H.*	1426
12.	,,	elegans	Theocyrtis elegans. *H.* or Artostrobus elegans. *H.*	1406 1482
13.	,,	pauperum	Theocyrtis paupera. *H.* or Artostrobus elegans. *H.*	1407 1482
14.	,,	versipellis	Theocampe versipellis. *H.*	1425
15.	,,	gracile	Sethoconus gracilis. *H.*	1295
16.	,,	attenuatum	Theocorys attenuata. *H.*	1417
17.	,,	(?) obstipum	Lithomitra acephala. *Büt.*	1484
18.	,,	panthera	Tricolocampe panthera. *H.*	1413
19.	,,	ficus	Theoconus ficus. *H.*	1403
20.	,,	microporum	Lithostrobus microporus. *Büt.*	1474
21.	,,	pachyderma	Lithomitra pachyderma. *Büt.*	1483
22.	,,	imbricatum	,, ,, *Büt.*	1483

Plate 12.

1.	Thyrsocyrtis	rhizodon	Thyrsocyrtis rhizodon. *Ehr.*	1350
2.	,,	bromia	Podocyrtis bromia. *H.*	1349
3.	,,	lyaea	,, lyaea. *H.*	1348
4.	,,	bacchabunda	Theocorys bachabunda. *H.*	1417
5.	,,	dionysia	Theoconus dionysius. *H.*	1402
6.	,,	pristis	(?)	
7.	,,	jacchia	Theoconus dionysius. *H.*	1402

FIG.			
8.	Thyrsocyrtis œnophila	Theocyrtis œnophila. *H.*	1408
9.	,, anthophora	Eucyrtidium anthophorum. *H.*	1491
10.	,, reticulata	Anthocyrtium reticulatum. *H.*	1274
11.	Podocyrtis dipus	(?) Podocyrtis tripus. *H.*	1349

PLATE 13.

1.	Podocyrtis princeps	Podocyrtis princeps. *Ehr.*	1342
2.	,, tetracantha	Alacorys tetracantha. *H.*	1371
3.	,, aculeata	,, aculeata. *H.*	1373
4.	,, triacantha	Podocyrtis triacantha. *Ehr.*	1350
5.	,, radicata	Thyrsocyrtis radicata. *H.*	1351

PLATE 14.

1.	Podocyrtis cothurnata	Dictyopodium cothurnatum. *H.*	1353
2.	,, centriscus	Podocyrtis centriscus. *Ehr.*	1341
3.	,, puella sinensis	Clathrocyclas puella. *H.*	1387
4.	,, domina sinensis	,, domina. *H.*	1387
5.	,, parvipes	(?) Alacorys tetracantha. *H.*	1371
6.	,, eulophos	Podocyrtis eulophos. *Ehr.*	1346
7.	,, Schomburgkii	,, Schomburgkii. *Ehr.*	1343

PLATE 15.

1.	Podocyrtis euceros	Podocyrtis euceros. *Ehr.*	1342
2.	,, rhizodon	Thyrsocyrtis rhizopus. *H.*	1351
3.	,, mitrella	Podocyrtis mitrella. *Ehr.*	1345
4.	,, mitra	,, mitra. *Ehr.*	1345
5.	,, sinuosa	,, sinuosa. *Ehr.*	1347
6.	,, papalis	,, papalis. *Ehr.*	1344

PLATE 16.

1.	Podocyrtis collaris	Podocyrtis collaris. *Ehr.*	1340
2.	,, argulus	,, argulus. *Ehr.*	1344
3.	,, ventricosa	,, ventricosa. *Ehr.*	1341
4.	,, aerostatica	Sethamphora aerostatica. *H.*	1252
5.	,, attenuata	Podocyrtis attenuata. *Ehr.*	1338
6.	,, brevipes	,, brevipes. *Ehr.*	1340
7.	,, (?) ampla	,, ampla. *Ehr.*	1348
8.	,, bicornis	,, tripus. *Ehr.*	1349
9.	,, argus	,, argus. *Ehr.*	1346

PLATE 17.

1.	Podocyrtis pentacantha	Alacorys pentacantha. *H.*	1371
2.	,, nana	Podocyrtis nana. *Ehr.*	1348
3.	,, amphiacantha	,, Ehrenbergii. *H.*	1344

FIG.			
4.	Pterocanium bombus	Pteropilium bombus. *H.*	1443
5.	,, (?) sphinx	,, sphinx. *H.*	1443
6.	,, barbadense	Pterocorys barbadensis. *H.*	1318
7.	,, contiguum	Pterocanium contiguum. *Ehr.*	1330
8.	Rhopalocanium ornatum	Rhopalocanium ornatum. *Ehr.*	1359

PLATE 18.

1.	Cycladophora gigas	Calocyclas gigas. *H.*	1384
2.	,, erinaceus	,, erinaceus. *H.*	1383
3.	,, stiligera	Cycladophora stiligera. *Ehr.*	1380
4.	,, (?) discoides	Theocalyptra discoides. *H.*	1397
5, 6.	,, spatiosa	Cycladophora spatiosa. *Ehr.*	1379
7.	Calocyclas turris	Calocyclas turris. *Ehr.*	1383
8.	,, barbadensis	Artophormis barbadensis. *H.*	1459

PLATE 19.

1.	Pterocodon campana	Pterocodon campana. *Ehr.*	1333
2.	,, campanella	Eucecryphalus campanella. *H.*	1223
3.	,, apis	Pterocorys apis. *H.*	1318
4.	Dictyopodium eurylophos	Dictyopodium eurylophos. *Ehr.*	1352
5.	,, oxylophos	,, oxylophos. *Ehr.*	1353
6.	Dictyospyris gigas	Circospyris gigas. *H.*	1072
7.	,, clathrata	Liriospyris clathrata. *H.*	1049
8*a*, *b*.	,, trilobata	Dictyospyris triloba. *Ehr.*	1074
9.	,, tristoma	,, tristoma. *Ehr.*	1074
10.	,, tridentata	Circospyris tridentata. *H.*	1072
11.	,, fenestra	Dictyospyris fenestra. *Ehr.*	1075
12.	,, tetrastoma	,, tetrastoma. *Ehr.*	1075
13.	,, spinulosa	,, spinulosa. *Ehr.*	1075

PLATE 20.

1.	Ceratospyris turrita	Liriospyris turrita. *H.*	1050
2.	,, heptaceros	Elaphospyris heptaceros. *H.*	1056
3.	,, fibula	Tympaniscus fibula. *H.*	1002
4.	,, articulata	Hexaspyris articulata. *H.*	1048
5.	,, ocellata	Brachiospyris ocellata. *H.*	1038
6.	,, mystax	Dipospyris mystax. *H.*	1036
7.	,, ramosa	Ceratospyris ramosa. *Ehr.*	1069
8.	,, furcata	Triceraspyris furcata. *H.*	1031
9.	,, dirrhiza	Dendrospyris dirrhiza. *H.*	1039
10.	,, stylophora	,, stylophora. *H.*	1038
11.	,, setigera	Hexaspyris setigera. *H.*	1047
12.	,, echinus	Ceratospyris echinus. *Ehr.*	1068

Plate 21.

FIG.			
1, 2.	Ceratospyris longibarba	Ægospyris longibarba. *H.*	1054
3.	,, triomma	Tripospyris triomma. *H.*	1026
4.	,, ateuchus	Cantharospyris ateuchus. *H.*	1051
5.	,, triceros	Tristylospyris triceros. *H.*	1033
6.	,, didiceros	Triceraspyris didiceros. *H.*	1030
7.	Cladospyris bibrachiata	Dendrospyris bibrachiata. *H.*	1039
8.	,, tribrachiata	Tripospyris tribrachiata. *H.*	1029

Plate 22.

1, 2.	Petalospyris argiscus	Petalospyris argiscus. *Ehr.*	1062
3.	,, diaboliscus	Anthospyris diaboliscus. *H.*	1065
4.	,, eupetala	Petalospyris eupetala. *Ehr.*	1061
5.	,, confluens	Patagospyris confluens. *H.*	1088
6.	,, carinata	Phænocalpis carinata. *H.*	1174
7.	,, flabellum	,, flabellum. *H.*	1174
8.	,, platyacantha	Petalospyris platyacantha. *Ehr.*	1060
9.	,, ocellata	Phænocalpis ocellata. *H.*	1174
10.	,, foveolata	Petalospyris foveolata. *Ehr.*	1060
11.	,, pentas	Gorgospyris ehrenbergii. *H.*	1070
12.	Perichlamydium (?) spirale	Perichlamydium spirale. *Ehr.*	499
13.	Flustrella concentrica	Porodiscus concentricus. *H.*	492

Plate 23.

1.	Stylodictya echinastrum	Stylodictya echinastrum. *Ehr.*	513
2.	,, clavata	,, clavata. *Ehr.*	513
3.	,, gracilis	,, gracilis. *Ehr.*	509
4.	,, setigera	,, setigera. *Ehr.*	512
5.	,, hastata	,, hastata. *Ehr.*	510
6.	,, Forbesii	,, multispina. *H.*	510
7.	,, ocellata	Staurodictya ocellata. *H.*	508
8.	,, perichlamydium	(?)	
9.	,, splendens	Staurodictya splendens. *H.*	508

Plate 24.

1.	Stylodictya bispiralis	Porodiscus bispiralis. *H.*	497
2.	Histiastrum ternarium	Hymeniastrum ternarium. *H.*	531
3, 4.	,, quaternarium	Histiastrum quaternarium. *Ehr.*	545
5.	Stylosphæra radiosa	Xiphatractus radiosus. *H.*	334
6.	,, sulcata	,, sulcatus. *H.*	333

Plate 25.

FIG.			
1.	Stephanastrum rhombus .	Stephanastrum rhombus. *Ehr.*	519
2, 3.	Stylosphæra liostylus .	Stylosphæra liostylus. *Ehr.*	136
		or Sphærostylus liostylus. *H.* .	138
4.	" coronata .	Druppatractus coronatus. *H.* .	326
5.	" flexuosa .	Sphaerostylus flexuosus. *H.* .	138
6.	" lævis .	Druppatractus lævis. *H.* . .	327
7.	" carduus .	Stylatractus carduus. *H.* .	330
8.	" spinulosa .	Xiphatractus spinulosus. *H.* .	332

Plate 26.

1.	Spongosphæra rhabdostyla .	Stylotrochus rhabdostylus. *H.*	584
2.	" " .	" "	"
3.	" pachystyla	Spongatractus pachystylus. *H.*	350
4.	Haliomma eutactinia .	Carposphæra entactinia. *H.* .	74
5.	" (?) cenosphæra .	Cenellipsis Ehrenbergii. *H.* .	291
6.	" medusa . .	Thecosphæra medusa. *H.* .	80
7.	" ovatum . .	Druppia ovata. *H.* . . .	309

Plate 27.

1.	Haliomma helianthus .	Heliodiscus helianthus. *H.* .	446
2.	" echinatum .	(?)	
3.	" Humboldtii .	Heliodiscus Humboldti. *H.* .	449
4.	" umbonatum .	" umbonatus. *H.* .	449
5.	" contiguum .	Heliosestrum contiguum. *H.* .	439
6.	" nobile . .	Carposphæra nobilis. *H.* . .	75

Plate 28.

1.	Haliomma sol	Heliosestrum solarium. *H.* .	439
2, 3,	" oculatum .	Haliomma oculatum. *Ehr.* .	234
4.	" triactis . .	Triactiscus tripodiscus. *H.* .	432
5.	" apertum . .	Staurolonche aperta. *H.* . .	159
6.	Periphæna decora . .	Periphæna decora. *Ehr.* . .	426

Plate 29.

1.	Haliomma perspicuum .	Staurolonchidium perspicuum. *H.*	162
2.	Lithocyclia stella . .	Astrocyclia stella. *H.* . . .	467
3.	" ocellus . .	Lithocyclia ocellus. *Ehr.* .	460
4.	Stylocyclia dimidiata .	Stylocyclia dimidiata. *Ehr.* .	462

Plate 30.

FIG.			
1.	Astromma pentactis . . (In outline only, the specimen having been lost.)	Pentactura pentactis. *H.* .	479
2.	Astromma Pythagoræ . .	Trigonactura pythagoræ. *H.* .	471
3.	,, Aristotelis . .	Astractura democriti. *H.* .	477
4.	,, ,, . .	,, aristotelis. *H.* .	476
5.	Hymeniastrum pythagoræ	Hymeniastrum pythagoræ. *Ehr.*	531
		or Hymenactura ,, *H.* .	474

Addition to Plate 30.

Limestone from County Antrim, Ireland, under the influence of volcanic action.

Fig. *a*. Finely polished fragments of marble of the natural size under glass, with dark background. The cross marks the enlarged fragment.

,, *b*. The indicated portion magnified 50 diameters. The cross indicates the organisms, which in

,, *c*. are drawn to a magnification of 100 diameters.

The remaining figures in the thirty plates are drawn to a uniform magnification of 300 diameters.

On the Minute Structure of some Diatomaceæ from Corica Bay, Melbourne.

By A. A. Merlin, F.R.M.S.

(*Read January* 19*th*, 1900.)

Plate 17.

A "circle" slide of selected Diatomaceæ from Corica Bay, although containing only well-known forms, has yielded some results under the highest powers which have interested me, and may prove new to other members of the Club, even should the points referred to have been previously observed. I feel that in any case I can rely upon their indulgence in broaching the old but ever-fascinating subject of diatomic structure, regarding which all advances hitherto made in the perfection of our objectives, and in the refinements of critical illumination, have served but to open vistas of new detail, and have left us apparently still far from any demonstrable solution of the mechanical cause of the life motions of these organisms.

The $\frac{1}{8}$-inch Zeiss apochromat of N.A. 1·4, illuminated by the full axial cone of Powell's dry apochromatic condenser, was employed in all the following observations, the diatoms being in a medium of somewhat high refractive index, probably monobromide of naphthaline and balsam.

The preparation contains several specimens of *Biddulphia* (*B. reticulata* Roper?) exhibiting complicated structure. Each areolation of the valve appears to be surmounted by an outer domed silicious film of great tenuity, on which extremely fine secondaries of the *Coscinodiscus asteromphalus* type have been glimpsed (Fig. 1). A fracture extending across one of these caps has admirably served to demonstrate both its delicacy and reality. On focussing down just sufficiently to render the image of the outer cap invisible, a second silicious plate comes into view (Fig. 2) decidedly more substantially built than the first, pierced by distinct, well separated, and fairly equidistant perforations, of

which ten have been counted within the space of one areolation. These latter secondaries are arranged in a totally different manner to those of the upper domed cap, and would probably be alone visible with a dry lens. This is the only example I have yet noticed of areolations crowned with double plates or caps, closely superposed, each bearing secondaries of a distinctly different type.

The next point to which I venture to call your attention is the existence of very fine structure on the upper surface of some *Navicula prætexta* valves, apparently extending over the entire area of the valve, when the primaries are held in distinct "black dot" focus (Fig. 3). I have worked on several occasions for hours together at these specimens, and have been unable to satisfy myself as to whether this appearance, which is almost at the limit of my vision, should be attributed to a surface roughening of the silex, analogous to that of ground glass, or to the presence of regular structure of surpassing minuteness. I have noticed a similar structural appearance on the surface of the hyaline bands of a *Navicula lyra* on the same slide (Fig. 4). It has been searched for on other forms, but without success.

Several valves of *Pleurosigma formosum* and one of *P. angulatum* have many of their so-called "markings" damaged and choked up, the individual "dots" being in numerous instances only partly filled in, while others adjoining are normally round. The broken edge of a *P. formosum* (Fig. 5) exhibits a projecting line of five "black dots," the first of which has been halved by the fracture, the second and third left entire, and the fourth and fifth partly carried away.

A fine specimen of *Auliscus*, apparently identical in structure with the *A. Oamaruensis* figured in our Journal for January 1887, has large processes with difficult secondaries of the *A. sculptus* type (Fig. 6).

Lastly, two *Orthoneis* valves, resembling in outline and size the *O. splendida*, have long rod-shaped primaries running at right angles to the raphe, each primary being slightly constricted in the centre, where it is bridged by a broad silicious bar (Fig. 7).

Although all the above are stated to be recent marine forms, the curiously weathered and dilapidated appearance of the structure on the *P. formosum* and *P. angulatum* valves in this preparation closely resembles that of a fossil *P. formosum* from Sendai, Japan, in my possession.

In studying minute diatomic structure with oil-immersion objectives and condensers, especially with the latter, type or group slides containing a large number of varied forms are a great convenience, as valve after valve can be critically examined without changing the slip—a somewhat tiresome operation when both its upper and under surfaces are in immersion contact with objective and condenser. The beautifully arranged and comparatively cheap grouped "circle" slides, containing from fifty to two hundred selected forms from numerous localities, are admirably adapted for this purpose. Every rose has its thorn, however, and the thorn in this case proves to be the fact that a large percentage of the valves arranged on such slides are so mounted as to present their concave inner surfaces to the observer, whereas, at any rate where only one example of each form is given, it is very desirable that the valve should be mounted with its outer convex surface uppermost. The utility of a beautiful type slide of four hundred forms, which I possess, is greatly diminished owing to this cause, many most interesting specimens on it being thus mounted inside out. The marvellous skill evinced in the arrangement of these preparations leads one to hope that mounters may be able to remedy this defect, especially in the more elaborate and expensive type slides.

When examining very minute objects with objectives of the highest power, employing large axial cones, I have found slightly averted vision to be of great assistance in steadily holding faint and difficult details. The utility of averted vision is of course well known in telescopic observations, but I have not heard of it hitherto being employed in microscopical work. In my own case I find that faint diatomic structure which can be just certainly held with averted vision becomes absolutely invisible when viewed directly.

I have been lately again working at the secondary structure on the *N. prætexta* and *N. lyra*, and have succeeded in holding it as distinct dots in both cases. My impression is, however, that while the secondaries all over the upper surface of the *N. prætexta* represent real structure, those of the *N. lyra* bands *may* be "false ghosts" formed by the adjacent primaries, as they are arranged across the bands in close rows parallel to the coarse structure; but, on the other hand, different specimens of the *N. lyra*, all possessing well-marked primaries, do not exhibit the

secondaries with equal certainty or distinctness, as I should imagine would be the case were they ghosts formed by the primaries.

Explanation of Plate 17.

(*All the figures have been drawn under $\frac{1}{8}$th-inch Zeiss apochromat.*)

Fig. 1. Areolation of a *Biddulphia* (*reticulata* Roper?). Secondary structure of outer cap.

Fig. 2. The same, showing structure on the inner plate.

Fig. 3. Central portion of *Navicula prætexta* valve, exhibiting fine secondaries. One specimen unmistakably shows the ends of the raphe pipes joined by a finer tube as figured. Other specimens only yield faint indications of this connection.

Fig. 4. Central portion of *Navicula lyra*, showing apparent secondary structure on the hyaline bands.

Fig. 5. Fractured edge of a *Pleurosigma formosum*, exhibiting a projecting row of five "black dots," three of which have been partly carried away.

Fig. 6. Process of a large *Auliscus* (*Oamaruensis*?) with fine structure resembling that of the *A. sculptus*.

Fig. 7. Large rod-shaped primaries of an *Orthoneis* valve, each constricted centrally and bridged by a broad silex bar.

THE PRESIDENT'S ADDRESS.

By John F. W. Tatham, M.A., M.D.,

Fellow of the Royal College of Physicians.

(*Delivered February 16th*, 1900.)

Since I last had the honour of addressing you from this chair another year has passed away, and, with the advent of its last evening, there has come to me the duty of once more giving account of the stewardship which your good-will committed to my keeping for the first time just two years ago.

It is again my privilege to announce that during the past twelve months the affairs of the Quekett Microscopical Club have continued to progress satisfactorily on the old lines. The number of new members enrolled during the year was thirty-eight, being a larger accession to our membership than any which has accrued in a single year since 1892, about which time our Club migrated from its old quarters in University College to its present home in Hanover Square.

This evening we have received the report of our Committee, and also that of our Honorary Treasurer; and by these you will note that not only have our meetings been well attended, not only has the interest of our members in the affairs of the Club continued unabated, but our finances have maintained a prosperous condition.

Our Committee, however, whilst prophesying hopefully with respect to the future, are careful to insist that every one of our members must recognise his individual responsibility towards the Club, and use his best endeavours to augment its list of subscribers, so as to secure such an income as will enable our Committee to conduct the future business of the Club as satisfactorily as it has been conducted in times past.

Having recently employed the few leisure hours at my disposal in examining certain lined tests mounted in media of exceptionally high refractive indices, I venture to offer a few remarks on the subject, which is a favourite one with some at least of our members. I cannot claim to have discovered anything really new, but I

have gained some experiences which have proved interesting to myself at any rate, and I trust that these may be either confirmed or refuted by other and more expert observers.

In what follows concerning optical appliances, reference will be made principally to the use of a remarkably fine apochromatic 3 mm. oil immersion by Zeiss, of N.A. 1·43. In a few instances, however, I have substituted for this a 2 mm. apochromatic of the same aperture, kindly lent me by a friend. The illumination employed has, for the most part, been that of an ordinary paraffin lamp with half-inch wick, the light being rendered suitable for my purpose by passage through a screen of signal-green pot glass, the thickness of which, and consequently the intensity of illumination, has been varied to suit the particular diatoms under examination. Occasionally, however, I have so far modified my practice as to substitute a methyl-green fluid screen for the simple pot glass; and to those who do not mind the extra trouble, I can recommend this expedient, not only as furnishing a pleasanter light, but also one of greater intensity, for the fluid screen unquestionably passes more light than does the dry one, and the flame is spectroscopically much more free from red rays. The fluid screen, however, has its drawbacks, although these will doubtless be overcome eventually, unless the screen itself is superseded by something better: I refer to the fact that so far, at any rate, no means has been discovered whereby the fluid (mainly glycerine) can be retained within the tank which is supplied by the makers for that purpose. The fluid inevitably gets heated in use, and, expanding, finds its way out of the tank and gives rise to much inconvenience.

Whilst dealing with the general question of illumination, I would throw out a suggestion which will be found of value to those who may be interested in the study of the most delicate structures by the help of wide apertures and other optical appliances of the most perfect type. I am convinced that even those observers who duly appreciate the value of malachite-green screens for the illumination of objects in the microscope, pay far too little attention to the quality of the diffused light of the room in which they work; the consequence being that the retina speedily loses that exquisite sensitiveness which it acquires when the quality and quantity of the light of the work-room are adapted to the circumstances.

There is no necessity for working in the dark, although access to the room of ordinary daylight, as well as of unscreened lamp-light, must be avoided. A good plan is to use a Cambridge reading-lamp placed at some little distance from the observer, its green-glass shade being so arranged as to prevent the access of any but modified rays to the eye. It would scarcely be believed, by those who have not tried it, how greatly the sensitiveness of the retina is increased by this simple proceeding, and how much more readily the most delicate details are perceived when none but rays thus modified obtain entrance to the work-room.

The medium with which the first of the experiments that I shall mention were made is a solution of biniodide of mercury in excess of iodide of potassium. This solution is very readily obtained, and, being an aqueous one, is easily retained within a ring of dammar and gold size cement.* I am indebted to Professor Fuller, of Surbiton, for a knowledge of the high qualities of this mounting medium, as well as for a considerable number of well-mounted slides which he has generously placed at my disposal. Unlike many other highly refracting media, the biniodide is colourless, and therefore requires no special modification of illumination. In common with some other mounting fluids, this medium seems to be suitable for only certain tests. Used on *Surirella gemma* and on *A. pellucida*, with suitable illumination and with direct light, it brings out structure with a clearness and beauty which I do not remember to have seen surpassed.

In mounting diatoms in this medium, however, care must be taken to make the film of fluid in the cell as thin as possible, for otherwise the diatoms, which are easily detached from the cover on which they are, or should be mounted, change their position rapidly whilst under observation in the microscope, and thus cause considerable annoyance. This might, of course, be remedied if an unobjectionable method could be devised of fixing the diatoms to the cover glass. Heating the cover glass with the diatoms *in situ* has been suggested, but this plan is certainly not always successful; and, as far as I know, there is no material, insoluble in water, which can be used for fixing the valves to the cover glass, and which will not at the same time damage the object for purposes of observation.

* Made after the excellent formula of Mr. Rousselet—viz., two parts of a saturated solution of dammar in benzol, and one part of gold size.

Another colourless medium with which I have lately been experimenting is phosphorus. Those who are familiar with the properties of this substance will readily understand that it is no easy matter to obtain a successful mount of objects in such an unstable medium. I am indebted to the kindness and generosity of my friend Mr. Morland, certainly the most accomplished manipulator of diatoms that I have ever met, for specimens of finely lined diatoms mounted in pure phosphorus. The slides I have were prepared about ten years ago, and although a spot of partially oxidised phosphorus has appeared in one of them, the diatoms are for the most part shown as clearly as though the mounts had been put up only yesterday. The refractive index of phosphorus is 2·2, and it appears to have no effect whatever on silicious structures.

The valves appear to have been fixed in some way to the cover glass, and consequently they do not annoy one by constantly shifting their position whilst under observation, as is frequently the case with specimens mounted in aqueous solutions. The diatoms in my cabinet mounted in phosphorus are, *Amphipleura pellucida*, *Frustulia saxonica*, *Pleurosigma angulatum*, *P. formosum*, and *Nitzschia sigmoidea.* All these forms appear to full advantage in this medium under my 3 mm. apochromatic of 1·43 N.A. The *A. pellucida* is especially brilliant, and the other forms reveal their minutest detail splendidly. If it were not for the extreme difficulty of manipulation, I think it probable that phosphorus would rapidly become a favourite mounting medium for objects of this class.

Quinidine is, I believe, amongst the members of the Club, a well-known material for the mounting of diatoms. It is perfectly colourless, easily manipulated, and requires no previous preparation. Quinidine is an ideal temporary mounting medium for those who prepare their own diatomaceous material. There is no other substance that lends itself so readily as this to rapid mounting; all that is required being to interpose a minute portion of it between the cover-glass bearing the diatoms and the slip, and then to fuse the quinidine by the help of a spirit lamp. Immediately on cooling, the slide is ready for examination; and if it so happen that a valve has emerged from the fusing process in a favourable position, it will remain fixed there, and the slide will require no ringing or further protection.

But, unfortunately, quinidine has its faults; for up to the present time no one has succeeded in preventing the crystallisation of this substance. Occasionally a slide will remain perfectly transparent for years. My friend Mr. Nelson possesses a slide of *Navicula rhomboides* in quinidine which has been photographed for Carpenter's work on the microscope, and which for ten years at least has shown little sign of change. But, generally speaking, quinidine mounts become opaque in the course of a few days, from the crystallisation of the medium; and then the only alternative is once more to fuse the crystals, which often results in the displacement of perchance your favourite valve, and consequently the ruin of your slide.

Realgar has occasionally been used as a mounting medium for diatoms. It possesses the high refractive index of 2·5, and consequently is a valuable means of "forcing out," so to speak, the ultimate structure of a suitable object. Its use, however, is attended by several drawbacks. In the first place, fusion of the material which is necessary for the mounting process requires the application of great heat, which liberates intensely poisonous fumes, thus constituting a real danger to life. In the second place, the high temperature employed frequently twists or distorts the valves, so that they are seldom found to lie flat on the cooling of the slide. And lastly, the colour of the finished mount is a deep yellow, and this seriously detracts from its value for purposes of critical examination. This last defect, however, admits of at least partial remedy by the use of suitably tinted glass screens interposed between the source of light and the condenser. In place of the malachite-green screen I have been in the habit of using a polished plate of bright blue glass, and this with the yellow medium forms a suitable combination, which I have found very pleasant to the eye, as well as helpful in aiding the resolution of difficult tests.

Whilst examining one of the earlier and less perfect mounts in realgar that found their way here from Germany, and which was so full of "air bubbles," or colourless spaces that it was discarded as unfit for sale by one of our principal opticians, I was surprised to find that a very perfect valve of *Amphipleura pellucida*, which lay, evidently by chance, in one of these colourless spaces, was resolved as easily as were any of the other valves lying in the deep yellow realgar! What is the

exact nature of the fluid or gaseous matter in these spaces I am quite unable to state; but I imagine that in the process of fusion the realgar is decomposed, and that some product of the decomposition of enormously high refractive index remains in the spaces referred to.

However this may be, it should be mentioned as a fact worth notice, that there is no difficulty in resolving the valve of *Amphipleura pellucida*, to which I have referred, with an ordinary $\frac{1}{10}$th-inch achromatic oil immersion of 1·3 N.A. by the help of direct light and a $\frac{3}{4}$-cone from a dry apochromatic condenser.

I have even resolved this particular valve with a water immersion $\frac{1}{4}$ of 1·26 N.A., made for me twenty years ago by Mr. Thomas Powell, and this with only very slight obliquity of illumination. I have not yet had an opportunity of trying the experiment, but I feel convinced that if a larger cone of aplanatic light could be used to illuminate this valve, my $\frac{1}{4}$-inch would resolve it with direct light.

The slides I already possess, mounted in realgar, have been prepared by Messrs. Thum. I have specimens of *A. pellucida* and a few Nitzschias, and also specimens of *P. angulatum* and of *Surirella gemma*. They are all spread slides, and the diatoms are certainly shown with exquisite clearness. There is, however, another objection to the employment of realgar, in addition to the serious danger to life from the inhalation of noxious fumes and the intensely yellow colour of the medium, to which I have already referred. The temperature necessary for the fusion of realgar is stated to be so high that it is impossible to mount a *selected slide* in this medium; for there is no adhesive substance yet known that will resist such a temperature, and consequently any trouble that may have been taken to arrange diatoms on the cover-glass is almost certain to prove fruitless.

Another medium which has given me satisfactory results of late, and for the knowledge of which I am again indebted to the kindness of Mr. Morland, consists of a combination of Piperine with Bromide of Antimony. This mixture is prepared by combining three parts by weight of Piperine and two of Antimony Bromide: it must be very gently fused over a spirit lamp, care being taken not to raise the temperature more than is necessary, or the mixture becomes charred and discoloured and consequently worthless. After the diatoms have been spread on the cover

glass in the ordinary way, a small portion of the mixture is placed between the cover glass and the slide and gently fused until a thin film of it unites the two surfaces. Only sufficient of the medium should be used to fill about two-thirds of the area of the cover glass, so that space may be left for a protecting ring outside the medium.

When the medium has set—which it does immediately on cooling—protection from the air is necessary in order to prevent decomposition of the combined salts. This is most readily effected by allowing a small portion of solid paraffin to run between the cover glass and the slide by capillary attraction, so as completely to surround the deep yellow medium. If, after this, the cover glass be encircled with a ring of Hollis's liquid glue, by the aid of a turntable, the mount will be complete; and, judging from the present condition of a specimen in my possession which was mounted ten years ago by Mr. Morland, this medium possesses high qualities of permanence.

I am indebted to Professer Fuller for a considerable variety of diatoms mounted in Piperine and Antimony Bromide. All the finely lined species—such as *A. pellucida*, *Nitzschia sigmoidea*, etc., —are beautifully shown in this medium, and so are *Surirella gemma* and the pleurosigmas; but it does not answer equally well for such diatoms as *Coscinodiscus*, or for any of the other coarse circular forms that I have examined, up to the present date.

A short time before the delivery of my former presidential address I had, for the first time, the privilege of examining a new achromatic condenser on the homogeneous immersion principle, so arranged as to transmit an aplanatic cone of at least 1·3 numerical aperture. Since that time I have had an opportunity of examining other similar condensers, some of them made by Messrs. Watson, and more recently one or two by Messrs. R. and J. Beck, the latter being simply and conveniently mounted, and being procurable at a very reasonable price. For ordinary purposes I do not believe that these instruments will ever supersede the carefully constructed dry condensers of N.A. ·90 or ·95, which have hitherto been in use almost exclusively. Oil immersion condensers require, for their successful employment, not only the most minute exactness in the measurement of the glass mounting slips, which, with the cover glass and medium together, must be just thick enough, and not too thick, to occupy the space between

the upper lens of the condenser and the plane of the object itself, when the former is in exact focus; but their adjustment demands also exceptional skill and patience; added to which their use greatly increases the risk of damage, either to the object or to the objective, during the process of finding and focussing the former.

The condensers of this form which I have already seen cannot be described as perfect, but I cordially recognise the praiseworthy attempts which opticians both in this country and abroad have made to improve an instrument which, for certain special purposes, seems to me to have a great future before it. I know that it is contended by many, whose opinion I esteem very highly, that it is useless to increase the aperture of substage condensers beyond N.A. 1·0, because the objectives of our best opticians are incapable of bearing the extra strain. To this I reply that if this be so our present objectives must be set aside for test purposes, and our opticians must be encouraged to produce lenses which shall stand a greatly increased illuminating cone. But is it really true that none of the objectives at present available will stand an aplanatic cone of more than N.A. 1·0? I do not think that this is the case. With respect to ordinary so-called achromatic oil immersions of from 1·2 to 1·3 N.A., I admit that an aperture of 1·0 will develop all their powers, and in many cases some of their defects as well; but I possess an apochromatic lens of 3 mm. focus and 1·43 N.A., which, on suitable objects, will not only stand a much larger cone than this, but will reveal additional structure without loss of brilliancy and without the slightest deterioration of image, when illuminated by a cone approaching 1·3 N.A. Nor is my own lens an exception, for at least three of my friends are the owners of objectives by the same maker, and of the same or of shorter focal length, concerning which the same statement may be made with truth. I am afraid it must be owned that the very considerable trouble and patience which are required in order that the undoubted advantages of oil-immersion wide-angled condensers may become apparent have deterred many competent observers from persevering in their use.

For myself, I confess that when I look back on the progress which opticians in this country, as well as on the Continent, have achieved within. say, the last quarter of a century—when I

compare the productions of the present day—the apochromatics both dry and immersion, of wide aperture, with the humbler productions of the "sixties" and the "seventies," I do not despair of seeing lenses in the near future as much superior to those of the present day as our best modern lenses are superior to the most perfect constructions of pre-apochromatic days. Even now, signs of improvement are not wanting. Within the last few weeks I have had an opportunity, through the courtesy of a member of this Club, of examining a number of lenses, both achromatic and apochromatic, by Mr. Reichert of Vienna, constructed on an entirely new principle, and of glass which is guaranteed to resist the effect of hot climates. These glasses, one and all, give an image of great purity and brilliancy. They stand fairly deep eyepiecing well, and have plenty of working distance, considering their uniformly wide aperture. If Mr. Reichert could be induced to construct objectives of equally high merit for the long 250-mm. tube, he would add not a little to his deservedly high reputation as a constructor of first-class objectives. Messrs. Leitz, too, have still further improved the series of lenses for which they have recently become famous. They have devoted their attention to the development to the highest attainable perfection of the achromatic lens, using several permanent varieties of Jena glass, but no fluorite, in their construction.

Then again, these lenses are really marvels of cheapness. I have recently selected a quarter-inch by this firm, possessing an aperture of ·77, which was scarcely distinguishable from an apochromatic. I tested this glass in every possible way, comparing it with glasses which had cost four times as much, and I was unable to detect in it any point of inferiority. The price of this glass was only 25*s*.

But I trust I shall not be misunderstood if I express my conviction that the cry for cheap objectives has been heard long enough. For my own part—and I am not alone in this respect—I should be glad to see opticians striving to excel one another, not so much in the further cheapening of "popular" instruments as in the construction of glasses of the highest possible excellence, both in respect of resolving and of defining power.

The experience of opticians both in this country and abroad will show that microscopists do not grudge a reasonable price for a really first-rate instrument. There will, of course, always

be a demand for the so-called students' instruments, at a relatively low price; but surely this ought not to be incompatible with the production of other and better lenses at a commensurate increase in cost.

It now again becomes a pleasing duty to acknowledge my personal obligations to my brother officers, and to all other members of the Club, for the kindness and support which I have received throughout this my second year of office. I cannot leave the chair to-night without placing on record my regret that, as a Club, we are losing the services of two of our most valuable officers—I refer to Mr. Nelson our Hon. Editor and Mr. Vezey our Hon. Treasurer. Our Committee have already expressed their sorrow at the loss they have sustained by the resignation of these gentlemen: and whilst desiring to associate myself with all the kind things which the Committee have said about our retiring friends, I will express the hope that as unofficial members of the Club, we may long enjoy the privilege of their companionship and co-operation.

We are fortunate in having two gentlemen amongst us ready and willing to supply the places so honourably filled by Mr. Nelson and Mr. Vezey. Mr. Scourfield has kindly undertaken the post of Editor, and in his hands we are confident that the high character of our Journal will be ably maintained; whilst in Mr. Morland we have an old and valued friend of the Club, who may safely be trusted to look after its pecuniary not less than its general interests.

It now only remains for me to thank you one and all for the confidence you have reposed in me throughout my two years of office. Duties elsewhere have prevented my devoting so much time as I should have wished to do to those of the presidency; but you have always shown a generous appreciation of the poor services which I have been able to render in the chair; and in handing over to my successor, Mr. Massee, the honourable position which I have, I trust, done nothing to tarnish, I bid you, officially, a grateful farewell.

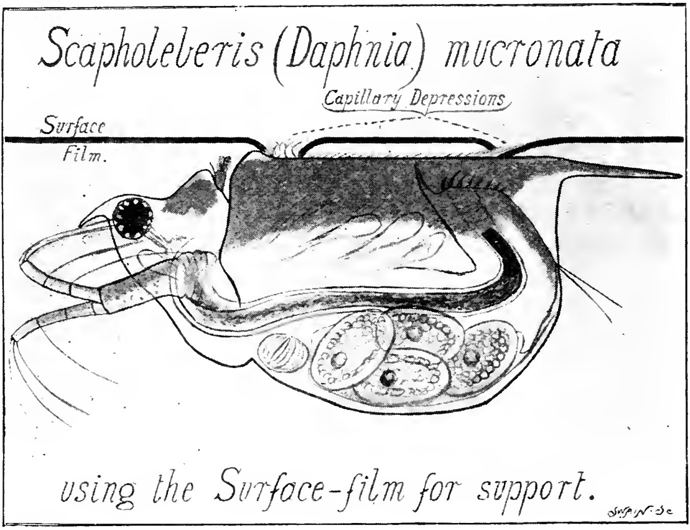
Note on *Scapholeberis mucronata* and the Surface-film of Water.

By D. J. Scourfield, F.R.M.S.

The habits of the different species of Entomostraca are very much more varied than is commonly supposed. Some forms swim continuously in the open water of clear ponds and lakes, some attach themselves in various ways to weeds, some crawl about the bottom, some burrow in the mud, some live habitually in wet mosses, and so on. But of all the peculiar modes of existence, that of deliberately making use of the ceiling of a pond, *i.e.* the surface-film of water, for support, is probably the most remarkable. So far as is known, only a very few species have acquired this power in a fully developed fashion, and these are all included in two genera—namely, *Scapholeberis* (Cladocera) and *Notodromas* (Ostracoda).

The accompanying figure, which is reduced from a diagram used in illustration of an exhibit made at the Club's Conversazione held at Queen's Hall on May 4th, 1897, shows a specimen ($\times$ 70 diameters) of *Scapholeberis mucronata* (*Daphnia mucronata* of Baird) in the act of clinging to the surface-film. The mechanism by which this is accomplished seems to be as follows. On the perfectly straight and flattened ventral margin of each valve there exists a series of very peculiarly modified setæ, the anterior and posterior members of which are larger and project somewhat more than the rest. (Full details of these characteristic setæ will be found in my paper on "Entomostraca and the Surface-film of Water," published in the *Journal of the Linnean Society*, *Zoology*, vol. xxv., 1894, pp. 1-19.) When the animal, which habitually swims in a reversed position, brings its ventral margin into contact with the surface of the water, the setæ which project farthest from the shell pierce the surface-film and produce minute capillary depressions. These depressions can be seen with a pocket lens if

the surface of the water, to which a *Scapholeberis* is clinging, be looked at in such a way that the light is totally reflected towards the eye. They then appear as four minute irregularities produced by the anterior and posterior groups of setæ on each valve. It is true that these irregularities cannot be actually seen to be depressions, but they certainly cannot be elevations, because it is a well-known physical fact that only when capillary depressions are formed can a weight be supported by the surface-film. But that is exactly what is happening in the case of a *Scapholeberis*



attached to the surface of the water, for on the one hand its body is decidedly heavier than water, and on the other it can be readily observed that the animal does not use its swimming antennæ when in contact with the surface, except for a stroke now and again to alter its position laterally.

It is quite certain, therefore, that the projecting setæ of the ventral margins of the valves in *Scapholeberis* do pierce the surface-film and produce capillary depressions, which, although very minute, are sufficiently large to support the difference in weight between the animal's body and the water which it displaces. It also follows that the setæ which produce these capillary depressions

must be water-repellent, a fact which is in harmony with what is known concerning the general surface of the shell in this and many other forms of Cladocera.

It must not be supposed that *S. mucronata* always lives suspended from the surface-film. On the contrary, the animal spends most of its time, perhaps, in clinging, probably by means of the hooks and setæ on its feet, to water plants, etc., and in swimming from place to place. But when the surface of the water in which it lives is calm, and especially when the sun is shining, *S. mucronata* comes up and remains for long periods in contact with the surface. That the animal obtains some of its food from the miscellaneous organic particles which collect on the surface is rendered almost certain by the fact that if an isolated individual, placed, say in a watch-glass, be observed under a low power of the microscope when at the surface, it can be seen that the particles on the surface are drawn between the valves by the normal beating of the feet. A very minute quantity of flour dusted on the water will show this action more plainly.

There is one other point to which attention may be directed, and that is the peculiar dark coloration of the ventral parts of the animal. This is very well brought out in the illustration, and it will be noticed that the coloration not only occurs on the shell, but also on the ventral parts of the large antennæ and the post-abdomen. The explanation that suggests itself at once is that this is a case of protective coloration; for the animal, in consequence of this darkening of the ventral surfaces, is certainly much less noticeable when seen from above over a muddy bottom than it would otherwise be. It is not known, however, whether *S. mucronata* has any enemies which prey upon it from above the surface of the water. It may very well be that some of the aquatic insects which spend part of their time on the surface are not unwilling to add this little Entomostracan to their bill of fare, but I have not been able to obtain any direct evidence of this.

From the foregoing remarks it will be clear that the utilisation of the curious physical properties of the surface-film of water by *S. mucronata* is no mere accident, but a very perfect adaptation of means to ends. This is all the more remarkable because the majority of the Cladocera and Ostracoda not only derive no advantage from the surface-film, but find it a positively dangerous factor in their environment, as may be seen by the helpless way

in which they remain suspended when brought accidentally into contact with the surface.

Evidently the whole subject of the relation of the Entomostraca and other small aquatic invertebrates to the surface-film is one well worth a considerably greater amount of attention than has yet been given to it. It is at least to be hoped that microscopists, when examining the little aquaria containing the spoils from their pond-hunting excursions, will be on the watch for any facts likely to throw light on the general problem or on the habits of individual species.

Note on the Genus Lacinularia.*

By Charles F. Rousselet, F.R.M.S.

As is well known, up to the appearance of Hudson and Gosse's monograph of the Rotifera in 1886, only one species of *Lacinularia* was known to science—namely, *L. socialis*—which occurs in clusters fixed to submerged plants, and is fairly common everywhere in Europe.

In that same year, however, Mr. Whitelegge, of Sydney, N.S.W., discovered a new and remarkable *Lacinularia*, which, instead of being fixed to water-plants, as *L. socialis*, forms a spherical cluster $\frac{1}{8}$ in. to $\frac{1}{4}$ in. in diameter attached to a peduncle $\frac{1}{2}$ in. long, the peduncle being formed by the fused secretion of the feet of the animals. Mr. Whitelegge sent over some contracted specimens preserved in spirit, and an account of the species was published by Dr. Hudson, who named it *L. pedunculata*, in the "Supplement" in 1889. Of course the characters of the genus had to be altered in order to include this semi-free-swimming form. Lately this species has again been found in abundance in Victoria, Australia, by Mr. John Shephard; and he has now sent me some very fine and well-preserved colonies, prepared, according to the directions I was able to send him. One of these is displayed under a microscope in the room. It will be noticed that the gelatinous tubes are quite absent in this species.

A year later another new species of *Lacinularia* was discovered by Mr. Western at Littleton. As this formed free-swimming spherical colonies like *Conochilus volvox*, it was named *L. natans*. The characters of the genus had again to be altered in order to admit this new species, which was first exhibited in this room in the spring of 1890. But, strange to say, the animals disappeared from the pond at Littleton in the autumn of 1890, and have never been found since in England. This was before the time of preserved Rotifers, and no specimens, therefore, were left for reference. But here again Mr. Shephard of Victoria has come

* Communicated in connection with an exhibit of six mounted slides, representing as many different species of *Lacinularia*, January 19th, 1900.

to the rescue, having been fortunate enough to find this same species in a lagoon on the other side of the globe. He has been good enough to send me over a preserved specimen, which I can therefore also show you under another microscope.

To the three foregoing species Mr. Shephard has lately added four more*—namely, *L. reticulata*, *L. striolata*, *L. elliptica*, and *L. elongata*, all of which, except the last, I can show you under the microscopes, having received very well preserved specimens from Australia. *L. reticulata* occurs in very large rounded clusters, sometimes as much as $\frac{1}{2}$ in. in diameter, attached to water-plants like *L. socialis*, from which it otherwise only differs in minor points. *L. striolata* is a very remarkable species, and was at first confounded with *L. pedunculata*, as it is attached by means of a horny peduncle to any submerged object. It forms large spherical or slightly oval colonies containing a very large number of individuals. Mr. Shephard, after counting the animals on a given area of a cluster $\frac{1}{5}$ in. in diameter, calculates that the whole colony contained 3681 individuals. The gelatinous tubes of the animals are fused into a homogeneous mass, and imbedded therein are seen thousands of eggs in all stages of development. The colony under the microscope is so well killed and preserved that every one of the animals is fully extended.

L. elliptica is again very peculiar in a different way. It forms free-swimming colonies of an elliptical shape, about $\frac{1}{10}$ in. in the long diameter. In the centre there is a well-developed, elongated axis, round which the animals are clustered. This of course gives the creatures more standing room than when all their feet converge to one point. In swimming the cluster revolves on the longer axis, which is nearly twice the length of the shorter axis.

Two more species of *Lacinularia* have been described by Surgeon Gunson Thorpe—one from Singapore, *L. megalotrocha*, and one from China, *L. racemovata*; but of these no preserved specimens exist at present.

* These species have been described by Mr. J. Shephard in the *Victorian Naturalist* of May 1896 and October 1897, and Proc. Royal Soc. of Victoria, 1892 and 1899.

Note on Specialisation in Cytology.

By G. C. Karop, M.R.C.S., F.R.M.S.

Long ago, somebody, I think it was O. W. Holmes, in discoursing on progress, stated or quoted to the effect that formerly a naturalist might justly claim to be conversant with the whole body of science. Then he became either a zoologist or a botanist, and later on he was forced to confine himself to one section in either. Finally, he could not properly style himself a coleopterist, for instance, but only a scarabæist! Specialism has, however, deviated into still narrower paths since the above was enunciated, as I was forcibly reminded on reading an elaborate monograph on the structure of some American Hirudinea in the "Nova Acta." * In discussing the anatomy of the nephridia the learned author, Dr. Arnold Graf, since deceased unfortunately, objects to the term 'Cytology' as far too general. He says: † Cytology is the doctrine of the cell, and is concerned with the total attributes of the same, and it is improper, for purely anatomical observations such as the description of cell-structures, to choose a title which in itself includes both morphology and physiology.

He therefore proposes the following elaborate plan for dividing up the science of Cytology:—

CYTOLOGY.

The doctrine of the attributes of the cell as a whole.

A. Cytomorphology.

The doctrine of the external form and size of the cell.

B. Cytoanatomy.

The doctrine of the intimate structure of the cell; the organisation of the cell.

* Nova Acta Acad. Leopold. Carol. Nat. Cur., Band 72, 1899

† Tom. cit., pp. 279-80.

C. Cytophysiology.

The doctrine of the living phenomena of the cell. This is further divided into:—

a. Cytomechanics.

The physical properties of the cell and its behaviour to mechanical stimuli. Further divided into:

1. *Cytostatics.*

A science which has not yet been cultivated, at least from a zoological standpoint, and which concerns the conditions of equilibrium of the cell and its structures.

2. *Cytodynamics.*

The doctrine of the phenomena of motion in the cell. With this is included the phenomena of cell-division, maturation, and fertilisation, the death of the cell, and in great part also the pathology of the cell.

b. Cytochemistry.

The chemistry of the cell might be divided into static or constitutional and dynamic. To static chemistry would belong the investigation of the chemical properties of the plasma and nuclear substance. To dynamic chemistry falls the processes of cell-metabolism.

Note on a New Hand Microtome.

This instrument, designed by Dr. Adriano Fiori, and made for him by Koristka of Milan, possesses one or two advantages over the ordinary simple pattern—advantages which we consider deserving of somewhat extended notice. For the enumeration of these advantages and details of construction we are indebted to a pamphlet by the inventor entitled "Nuovo microtomo a mano con morsetta tubulare," * in which he describes the instrument at some length.

The following is an abridged translation :—

Hand microtomes are employed with advantage, especially for the study of the histology of plants in which a great amount of the material sectioned does not require embedding. In the first place they are cheap, and well within the reach of the student; secondly, it is possible to give to the knife a cutting motion in contradistinction to the planing motion common to all but the largest and best of the purely mechanical section-cutting machines.

Hand microtomes consist essentially of two parts: (1) the guide for the knife; (2) the holder carrying the material to be sectioned and the micrometer screw by which this material is raised after each stroke of the knife. The former of these can be disregarded, as practically all patterns agree in this particular, the difference of the material for the top plate, whether brass or glass, being merely a question of detail. The latter, however, admits of more variation, and it is in this part that the instrument we are now describing differs from those that have gone before.

In the simplest models the material to be cut is wedged into the cylinder by pith or cork, the micrometer screw acting on the mass thus wedged together, and pushing the whole up through

* Extract from "Malpighia," vol. 13, 1899. The Club is indebted to Mr. R. Eram for translating Dr. Fiori's paper, and to Mr. C. L. Curties for revising the mechanical details. It is understood that the cost of the microtome, including carriage, would be about 25*s.*—Ed. Journal Q. M. C.

the cylinder. This is open to two objections: firstly, the material, if at all delicate, is liable to be crushed whilst wedging it into the cylinder; secondly, the motion upwards of elastic material such as pith or cork cannot possibly be regular. This latter

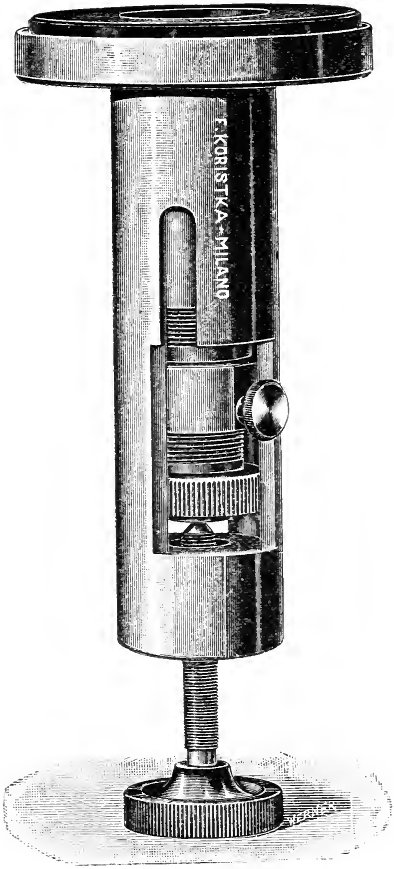


Fig. 1.

objection, although not the former, has to some extent been removed by employing a double cylinder, the one in which the material is held being moved bodily upwards by means of the micrometer screw. In yet another pattern a clamp has been added so as to remove the first objection urged; but the microtome

which is here figured meets all these objections, at the same time supplying a clamp far more efficient than anything which has yet been introduced.

Fig. 1 gives the general view of the instrument, which, it will be seen, does not depart materially from the common form. At the top it has the usual circular stage serving as a guide for the knife, and at the bottom a micrometer screw, the milled head of which is divided into ten parts, the rotation of the screw through one of these divisions giving an upward movement of $\frac{1}{20}$ mm.

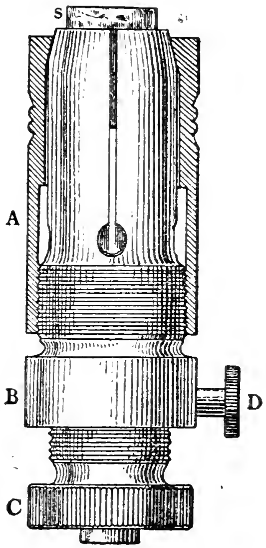


Fig. 2.

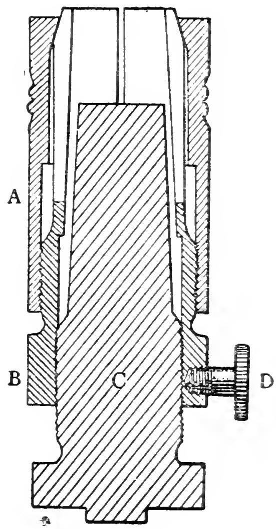


Fig. 3.

Figs. 2 and 3 show the internal arrangement of the instrument, consisting of three separate parts, A, B, and C, of which B is the object-holder. This part B resembles somewhat a crayon-holder of large size, with four slits; and it is so arranged, by means of a cone fitting, that when the object surrounded by the packing of pith has been introduced into its upper end it can be clamped by means of the outer cylinder A being screwed upon B. Such a method of clamping the object, in that it gives equal pressure and support from all sides, is far preferable to the one-sided clamp generally used.

The third part, C, which is of solid metal, rests directly on the micrometer screw. It runs up through B, the object-holder proper, and by means of a screw serves to protrude just so much material as is required. Should the amount of material exposed be found insufficient, after a number of sections have been made, it is only necessary to release the clamp screw D, and advance C by screwing, thus forcing out the material from the clamp, the latter having been first released, if necessary, by means of A. The clamp screw D serves also to prevent the metal carrier projecting through the stage, and thus injuring the knife. This is effected by so regulating the position of the upper edge of the large slot (see Fig. 1) that the milled head reaches it before the carrier has quite reached the top of the stage. By means, however, of the narrower slot, into which the milled head D will just pass, it is possible to push the carrier out of the body of the microtome when required.

NOTICES OF RECENT BOOKS.

Das Leben der Binnengewässer. By Professor Dr. K. Lampert. Pages xvi and 591; 8 coloured lithographic and 4 collotype plates; 223 figures in the text. Leipzic: C. H. Tauchnitz, 1899. Price 18 marks.

This work on "Pond-life" in its widest sense,—that is as practically synonymous with fresh-water biology—is probably the most important general review of the subject that has yet been published. Naturally it resembles in some respects the excellent "Thier- und Pflanzenwelt des Süsswassers," which was issued, with the assistance of a number of specialists, by Dr. O. Zacharias, the Director of the Plön Fresh-water Biological Station, nearly ten years ago. But it contains a large number of facts which have been brought to light since that time, and the treatment of the different divisions of the subject-matter is more uniform than was the case in the "Thier- und Pflanzenwelt des Süsswassers."

The book is divided into two principal parts, which deal with fresh-water animals and plants viewed respectively from the systematic and the biological standpoints. Preceding these, however, there is a very good historical survey of the progress of fresh-water biology from the days of Leeuwenhoek to the present time. Especially interesting reading is the account of how, after a period of stagnation, owing to the gravitation for a time of nearly all biological investigation towards the sea, the systematic study of the life of inland waters has, within the last ten years, again commenced to take its proper place in the estimation of naturalists in nearly all countries—except our own.

The systematic portion of the book, which occupies more than 420 pages, appears to be exceedingly well done. Of course it is not to be expected that in a single volume every group can be treated with monographic fulness. But the amount of information which has been packed into this section is nevertheless quite

remarkable. With the exception of the vertebrates, which are not dealt with in this work, not a single type of European fresh-water organism appears to have been forgotten. Many groups about which very little or nothing is said in most of the books on pond-life—such as the insects, parasitic copepods, parasitic worms, the aquatic fungi, etc.—are referred to in considerable detail. In nearly all cases the majority, if not all, the genera are alluded to, and keys to these are also added in order to facilitate the fixing of the approximate position of any specimen that may be found.

The biological part, although not nearly so long as the systematic, is in some respects more important. An attempt is made, and with considerable success, to give a comprehensive survey of what has been accomplished, especially in the last few years, in the study of fresh-water biological problems. The subject of the "plankton" of lakes and ponds, and the methods of plankton investigation, necessarily receive a good deal of consideration; and those who wish to get some general idea of what must certainly be regarded as one of the most important recent departures in biological work could not do better than read this section of Professor Lampert's book.

The illustrations are very numerous and largely original. It must be confessed that the coloured plates, in spite of the skill evidently expended on them, are not altogether a success; but the remaining plates and the woodcuts are excellent.

Altogether "Das Leben der Binnengewässer" is a book which can be heartily recommended to students of fresh-water biology in any of its branches. It will not take the place of the costly monographs and technical papers with which the specialist has to work, but as a general book of reference for professional and amateur alike its value would be difficult to overestimate.

D. J. S.

The Illustrated Annual of Microscopy, 1900, pp. 148, numerous illustrations. London: Percy Lund, Humphries & Co. Price 2*s.* 6*d.* net.

Editor and publishers may be congratulated on the appearance of their second volume, which in matter and illustrations is an advance on the first, good as that undoubtedly was. In any attempt to cater for microscopists at large a somewhat wide range of subject must be embraced, and so we find some two dozen articles, comprising Brass and Glass, Methods, Photography, Biology, and Miscellaneous. Included in the latter is one entitled "The Light Side of Microscopy," by Mr. Roscoe, who has disinterred some of the fun brought out at the bygone annual dinners of the Quekett Club, when the genial influences of Dr. Cooke and other kindred spirits, now mostly dead and gone, had full play. The progress recently made in process illustration is well seen in this book. The frontispiece is a reproduction in tint of Richter's charming picture of "Pond Life," and Mr. Scourfield's "Hyaline Daphnia," as viewed by dark-ground illumination, is one of the best process-blocks we have ever come across. Mr. Noad Clark's photographs of butterfly and moth eggs and entomological structures are also excellent; and it is, indeed, invidious to particularise when nearly all the illustrations are of high character. The concluding chapter deals with the latest productions of our leading opticians, and should be of value to country residents, who have fewer opportunities of seeing these as they are brought out. Taken all round, it is a marvellous half-crown's worth, and should be the property of every microscopist. G. C. K.

Common Objects of the Microscope. By the late Rev. J. G. Wood, M.A. Second edition, revised and rewritten by E. C. Bousfield, L.R.C.P., pp. x and 186, 14 plates. London: G. Routledge & Sons, Ltd. Price 3*s.* 6*d.* With plates uncoloured, 1*s.*

We are very pleased to see a second edition of this book, which, in the words of its reviser, has been the guide, philosopher, and friend of thousands of commencing microscopists. We are also reminded that thirty-six years have gone by since it was first

published, although it has been reprinted times out of number; and to bring such a comparatively venerable work quite up to date would mean rewriting it almost entirely. This Dr. Bousfield has, we think wisely, avoided, and, while making some very necessary corrections and additions to the preliminary part and the sections relating to preserving and mounting, he has left the descriptive portion mostly untouched, except where the advance of knowledge has made alteration imperative. The first chapter, however, is partly, and the second, third, eleventh and twelfth entirely new; and the reviser has also given some fresh matter amongst "Pond Life," including two new plates from his own drawings. The twelve original plates by Tuffen West are, of course, unaltered, and except that they are naturally not now quite so sharp as in the earlier impressions, remain amongst the best delineations of microscopic objects in any popular book. We have noticed but few errors of any importance, although "gory dew" is not one of the Palmellaceæ, but one of the chromogenous bacteria, allied to, if not identical with, *Bacillus prodigiosus*; Pediastrum is not a desmid; *Bacillaria paradoxa* is hardly a common *fresh-water* form; and we greatly doubt if any desmids can now be obtained "from a little pond on Blackheath." In all probability the revised work will continue to be as popular as ever with the class for whom it was originally written.—G. C. K.

WHO'S WHO, 1900. An Annual Biographical Dictionary. Fifty-second year of issue; pp. xviii and 1092. London: A. & C. Black. Price 3*s.* 6*d.* net.

Even microscopists, we presume, are not entirely free from the human frailty of desiring to know, on occasion, "Who's Who," and in the volume for 1900 they may find a very copious, if condensed, biographical epitome of everybody who is anybody in these islands. Beyond the information comprised in the title, the book contains particulars of interest on many subjects not otherwise attainable without considerable search: such as, for instance, societies and their officials, newspapers and their editors, Fellows of the Royal Society, a copious list of abbreviations, the proper pronunciation of our peculiar proper names, and a great deal besides. In fact, "Who's Who" is indispensable on every writing-table.

G. C. K.

AN INTRODUCTION TO STRUCTURAL BOTANY. Part 2. Flowerless Plants. By D. H. Scott, F.R.S. etc. Third Edition, 1899, pp. viii and 311. London: A. & C. Black. Price 3*s.* 6*d.*

Following the same line as Part 1 (Flowering Plants), Dr. Scott has selected a number of type forms among the Cryptogamia, and built upon them a series of morphological studies of the highest value to the student. While it was possible to outline the structure of the Phanerogams by the description of three types, in the present volume twenty-three have been found necessary for the elucidation of the lower division of plants, owing to their great variety of organisation, and even this involves the omission of several important groups. Condensed as the matter must of necessity be, it is far more than is implied by the title, as formerly understood, and does not merely consist of bare statements, however accurate, but conduces to the employment of reasoning, without which, as the author remarks, morphology is of no educational value. The vascular cryptogams are taken first, the types being Selaginella, the male-fern and *Equisetum arvense*; then the liverworts and mosses, exemplified by Pellia and Funaria respectively. The algæ and fungi follow and there is a short chapter on Bacteria and finally one on the Myxomycetes. Throughout, easily procured material is for the most part utilised, which is of great advantage for home work. The concluding summary will be most valuable to the thoughtful student, and while it points to the difficulty or impossibility of fixing affinities in plants, it indicates how often apparently divergent forms employ somewhat similar means of reproduction, and shows clearly the complexity of the problems concerning the descent of plants, which at present can be mostly only guesses. The work is well illustrated by 116 figures, some being original drawings by Mrs. Scott. Written in the clearest manner, it is, like the preceding volume, an altogether excellent work and must prove invaluable to the student who desires to extend his acquaintance with the higher developments of plant morphology.

G. C. K.

"RECENT FORAMINIFERA. A descriptive catalogue of specimens dredged by the United States Fish Commission Steamer *Albatross*." By James M. Flint, M.D., U.S.N. Printed in the Annual Report of the Smithsonian Institution for the year ending June 30th, 1897. Washington, 1899, pp. 249—349, 80 plates.*

This work is of great interest to the rhizopodist, inasmuch as it contains a catalogue of the foraminifera obtained during the dredging operations of the United States Fish Commission steamer *Albatross*, which were conducted around the Atlantic and Mexican Gulf coast-lines of the States, and also at a few stations in the Pacific Ocean. The results are most copiously illustrated by a series of no less than eighty admirable plates, including several hundred figures.

The author's purpose as stated in his preface is "(1) to record the results of an examination of a portion of the bottom material obtained during the dredging operations; and (2) at the same time to furnish a convenient book of reference for those who are or may become sufficiently interested to continue the study of this material."

As regards the author's first intention, it is stated that only a portion of the material obtained has so far been examined, and this not exhaustively, so that the list of species recorded will probably be largely extended at some future time. We venture to suggest that the value of the catalogue would have been greatly increased if the distribution of the species had been more thoroughly worked out.

The list of species is preceded by a short account of the life history and organisation of the foraminifera, which, in view of the author's hope that his work may form a work of reference for intending students of the order, as it well may, might with advantage have been more exhaustively treated and more carefully written. For instance, the author uses the word "colony" in a manner which implies that the polythalamous foraminiferal

* Also published separately. The agents of the Smithsonian Institution, Messrs. W. Wesley & Son, 28, Essex Street, W.C., supply copies in this country at 7*s*. 6*d*. net.

shell is the habitation of a number of individuals living socially together within a common investment after the manner of the Polycyttarian Radiolaria. This, of course, is wholly incorrect; the Foraminifera whether unilocular or multilocular, are "individuals," and the successive segments have no more separate existence than the leaves on a plant, though, like them, they might under favourable conditions reproduce their kind.

The classification adopted is in the main that of Brady, but certain alterations have been made in the arrangement of the families with very questionable advantage.

The rearrangement of the families appears to be due to the author's views on the value of the arenaceous test as a distinctive mark, although the general tendency of modern research has been to minimise its importance.

As regards the illustrations, which are all reproduced by process on a black ground from actual photographs of the foraminifera, nothing but satisfaction can be expressed. With the exception of the *Challenger* report there is no recent work on the Foraminifera so profusely, and on the whole, so admirably illustrated as this. The uniform magnification of 15 diameters adopted for all the species, although somewhat of a drawback as regards the minuter forms, gives a general idea of the relative dimensions of the several species which cannot but be of value to the young student. We believe that this is the first occasion on which direct photographs of foraminifera have been used, at any rate to such an extent, for the purposes of illustration, and any microscopist will appreciate the difficulty of successfully photographing such thick and solid opaque objects. It is therefore sufficient to remark that, with very few exceptions, the figures are all that could be desired, the contour, markings and nature of the test being clearly distinguishable, while in some of the best illustrations the texture and the hyaline transparency are reproduced with a faithfulness which no engraving or lithograph could equal.

A. E.

THE MYCETOZOA. By the Rt. Hon. Sir Edward Fry and Agnes Fry, pp. viii and 82; 22 figures in text. London: "Knowledge" Office. Price 1*s*.

This little work is well worth careful consideration. The authors, very properly, refuse to assert dogmatically that these highly interesting organisms belong to one or other kingdom, and prefer, at present, to refer them to neither. For our own part, we do not see why they should not be both animal and plant, at different stages of their life's cycle, however paradoxical this may appear to a rigid formalist. In any case the problems concerned are treated in a philosophical spirit and suggestive manner. With this book, and Mr. Lister's excellent British Museum "Guide" (price 3*d.*) the microscopical observer will possess sufficient information to enable him to fruitfully prosecute the study of this most fascinating group. G. C. K.

PROCEEDINGS.

October 20th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the meeting of June 16th, 1899, were read and confirmed.

The following donations to the library and cabinet were announced, and the thanks of the Club voted to the donors:—

"Journal of the Royal Microscopical Society"	From the Society.
"The Botanical Gazette"	" Editor.
"Proceedings of the Royal Society" ...	" Society.
"Bulletin of the Belgian Microscopical Society"	" "
"Proceedings of the Geologists' Association"	" "
"Proceedings of the Natural History Society of Philadelphia"	" "
"The Missouri Botanical Gazette" ...	" Editor.
"Proceedings of the Manchester Philosophical Society"	" Society.
"Pıoceedings of the Botanical Society of Edinburgh"	" "
"Transactions of the Hertfordshire Natural History Society"	" "
"Transactions of the Norfolk and Norwich Natural History Society"	" "
"Transactions of the Croydon Microscopical Society"	" "
"Journal of the Royal Institution of Cornwall"	" "
"Journal of the Northumberland and Durham Natural History Society"	" "

"The Journal of Applied Microscopy" ...	From the Editor.
"La Nuova Notarisia"	" "
"Proceedings of the Royal Society of New South Wales"	" Society.
"Proceedings of the Netherlands Zoological Society"—2 Nos.	" "
Six Slides of Australian Ticks—from Mr. Pound	From Mr. R. T. Lewis.

Mr. Curties exhibited Mr. Turner's chromoscope, showing some photomicrographs taken under low powers, and exhibiting the natural colours of the objects when seen through the instrument.

Messrs. Watson exhibited a new school microscope specially designed for educational work. It had no fine adjustment, but had a very well made coarse adjustment, an inclining body very firmly and rigidly constructed, and standard fittings for the substage. They also exhibited their new holoscopic eyepiece, which, by a simple arrangement for altering the distance between the field lens and eye lens, could be adjusted to compensate the corrections of the objective; a scale on the side enabled the best position for correcting any particular objective to be noted.

The thanks of the Club were voted to Messrs. Curties and Watson for their exhibits.

Mr. Karop thought Messrs. Watson were to be congratulated upon producing a microscope of such excellent quality at so low a price as £3. He remembered that the first microscope he possessed cost about the same, and was very poor and inferior in comparison to this, which was really strong and extremely well made. He thought it was also quite a move in the right direction to provide a good coarse adjustment in place of a shaky fine adjustment.

Mr. E. M. Nelson said he had seen Messrs. Watson's new eyepiece, but it was not exactly a compensating eyepiece in the strict sense of the term, but was an ordinary Huyghenian eyepiece, in which the distance of the lenses apart could be adjusted, and it was open to doubt whether the ordinary microscopist would not be more likely, in attempting to improve the adjustment, to spoil it altogether. He thought it would be better if it were marked off for long tube and short tube instruments; the present markings were empirical, but it was an

exceedingly difficult matter to make an accurate adjustment in this way, especially as the draw tube had to be considered.

The President said they would be glad to hear Mr. Nelson's opinion upon this eyepiece, and he could quite understand the difficulty of using it as a correction, seeing how difficult it seemed to some people to properly use the ordinary correction collar.

Mr. E. M. Nelson said they had three microscopes sent for exhibition by Messrs. Baker: the first was Reichert's "Austrian" model, fitted with an entirely new fine adjustment, in which there were two levers bearing upon each other, interposed between the micrometer screw and the top of the pillar. The microscope itself was essentially the old form, but with an invention applied to it by which the fine adjustment was immensely improved, so that whereas in the old form the speed was at the rate of $\frac{1}{75}''$ for each turn, it was in the new form only $\frac{1}{250}''$. Another good feature was that the indicator for the divisions on the milled head was adjustable so that it could be put at zero at any time, enabling the reading to be obtained direct instead of having to reckon it; the coarse adjustment was also adjustable so that they could get either a loose or a tight rack. The first Continental microscope with a sprung rack was made by Leitz, but this one of Reichert's was made on a different principle. The instrument had a $1\frac{1}{2}''$ substage and a horseshoe foot. The second microscope was practically the same, only more elaborately and expensively fitted. The third was a new and cheap form containing a condenser formed of a loup in the manner he had himself suggested some time ago. It was not usual to mention prices, but he thought under some circumstances it was permissible to do so, and although very well made they would perhaps be astonished to find that this microscope was sold for £2. The tendency now seemed to be towards making thoroughly good working instruments at low prices.

Mr. Nelson also exhibited one of Messrs. Watson's Edinburgh Students' Microscopes fitted with his stage and his latest improved coarse adjustment—viz., a stepped rack formed of two plain racks with a single pinion. In the ordinary rack-and-pinion movement there was always a slight loss of time between the change of direction of the movement, but in the case of the stepped rack one worked on the upward and one on the downward movement, the result being that the pinion acted at once, and there was

no loss of time whatever, even when the pinion was pressed lightly into the rack.

The President asked if Mr. Nelson thought the fine adjustment to the substage was of any great value.

Mr. Nelson thought it was certainly so in cases when oil-immersion condensers were being used.

The thanks of the meeting were voted to Mr. Nelson for his remarks.

Mr. J. G. Waller read a paper on an undescribed species of British sponge, *Raphiodesma affinis*, illustrating the subject by drawings upon the board.

Mr. Karop asked if Mr. Waller could give them any idea as to the practical use of the anchorate spicules.

Mr. Waller said that Dr. Bowerbank called them "retentive," but was abused for so doing, so he thought they could not enter into that subject.

A vote of thanks was then passed to Mr. Waller for his paper.

Announcements of meetings for the ensuing month were then made, and the proceedings closed with the usual conversazione.

November 17th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the ordinary meeting of October 20th, 1899, were read and confirmed.

The following donations were announced :—

"The Journal of Applied Microscopy"	From the Publishers.
"Proceedings of the Canadian Institute"	" Institute.
"Proceedings of the U.S. National Museum"—Vol. 21 ...	" U.S. Government Department.

The thanks of the Club were voted to the donors.

Special attention was called by the Secretary to the new volume of reports of the United States Museum, the papers in which were in many cases very valuable.

A series of photographs of the plates in Ehrenberg's "Radiolaria from Barbados," a supplement to the "Mikrogeologie," were

presented by Mr. Mottram, and the thanks of the Club voted to that gentleman for his donation.

The following gentlemen were balloted for and duly elected members of the Club:—Messrs. E. E. Green, Rev. Edward John Holloway, John Stevens, Edgar J. Summers, Charles Hoole.

The Secretary said that most of the members were probably aware that since their last meeting they had lost in a very sad way one of their most useful members, Mr. J. W. Reed. The Club had been indebted to him in many ways: he had rendered them considerable service at their soirées by securing a most excellent band free of all cost; and he had also read papers, amongst which those on Pyrenean plants and on the fungus diseases of plants would be particularly remembered. They would all miss him very much, and his loss as a member of their Committee would also be much felt.

The President said that at the meeting of the Committee that evening a vote of condolence and sympathy with the family of Mr. Reed had been passed, and he was sure that this would meet with the concurrence of the Club as a whole.

Mr. Karop said they had received from Mr. Curties for exhibition a very ingenious microscope by Leitz; it was non-inclining, with a folding two-limbed base, coarse and fine adjustments, removable stage and substage fitting with a simplified Abbe and iris. It appeared to be strong and well made, and he believed it was priced at £4 for the instrument as it stood, without oculars or objective.

The President said this seemed to be a modification of an earlier form, which was, however, not so convenient and portable as the one before them. This one seemed to be remarkably well made, and it would no doubt be a very useful instrument for any one wanting a good, small microscope.

Mr. Earland read a paper on the *Radiolaria*, illustrating the subject by a diagram on the board, and by specimens exhibited under the microscope in the room.

The President said they had all listened with great pleasure to what he would not call a paper, but rather a most elaborate and carefully finished essay. The subject was one which personally he knew nothing about, but he was sure that any one who had studied these forms would find this paper of very great interest.

Mr. Karop pointed out some of the similarities and differences between these organisms and the Foraminifera, showing that whilst both of them carried on the process of respiration in the same way, the assimilative processes appeared to be quite different. He was sure Mr. Earland's paper would be very much appreciated by those who had an opportunity of reading it when printed.

On the motion of the President the thanks of the Club were unanimously voted to Mr. Earland for his paper.

The Secretary announced that the vacancy which had occurred upon the Committee through the death of Mr. J. W. Reed had been filled up that evening by the Committee, who had appointed Mr. Earland. He was sure the choice of the Committee would be cordially approved by the members generally.

Notices of meetings, etc., for the ensuing month were then made, and the proceedings terminated with the usual conversazione.

December 15th, 1899.—Ordinary Meeting.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. H. P. Angus, Mr. William Ayrton, Mr. J. G. Johnson, Mr. Alfred E. Royle.

The following additions to the library were announced:—

"The Botanical Gazette"	In exchange.
"The Journal of Applied Microscopy"	" "
"Annals of Natural History"	" "
"Report of the Southport Society of Natural Science	" "
"Proceedings of the Royal Society"	" "

Messrs. Baker exhibited the following new microscopes by Leitz:—

The Leitz-Nebelthau Sliding Microscope.—The chief point of interest in this instrument, which is suitable for low power only (either a dissecting lens, or a compound microscope with rack and pinion coarse adjustment being attachable) is in the large

surface which can be brought under examination. The stage measures 20 × 16 cm., and practically every point in this area can be brought under the lens; this is effected by two mechanical movements, the stage itself moving backwards and forwards by rack and pinion, and the microscope transversely by means of a quick-acting screw; both movements are provided with graduated scales, and illumination is secured by a long rectangular mirror. Such an instrument will perhaps find its chief use in the Bacteriological Laboratory for the examination of plate cultures.

The Leitz-Dolken Stand.—This instrument is a modification of their well-known stand No. 1. Focussing and substage adjustments are identical, the modification being in the distance from optic axis to limb, or pillar carrying the fine adjustment. The short distance usual in all Continental models makes the examination of large bacteriological culture plates difficult, if not impossible. In the present model this distance is increased to about double that usually available, and is obtained by mounting the upper part of the microscope on one limb of an U-piece, the other limb being firmly attached to the stage. Large culture plates can thus be passed under the pillar carrying the fine adjustment.

The President said the latter of these instruments was a very old stand indeed, with a greater length of arm than usual. It was exceedingly solid and well made, and provided with a substage and condenser. The other seemed to be extremely novel, and of use chiefly for large sections.

Mr. Karop said the Leitz-Nebelthau microscope was obviously a specialists' instrument, and would no doubt be found very useful for looking over very large sections say of brain, or bone, or sections of wood. It was graduated in both directions, which would enable the position of any point of interest to be recorded for future reference. It no doubt had its special uses, but it was altogether a too elaborate instrument for the ordinary microscopist. The other instrument seemed to have nothing particularly new about it, except the point which had been mentioned; but he thought the price (£10) would hardly conduce to its adoption.

The thanks of the Club were voted to Messrs. Baker for sending these instruments for exhibition.

Dr. Tatham said he had an announcement to make which he felt would be received with feelings of great regret: it was

that Mr. Vezey, who had for so long and so admirably filled the office of Treasurer, had found it necessary to resign. They had all found it impossible to induce him to reconsider this decision, because the reason which had obliged him to take this step was the condition of his health. This would be to all of them an additional cause of regret; but although they would be exceedingly sorry to lose him, they could not under these circumstances press the matter further upon him. They would, however, all feel that Mr. Vezey would carry with him into his retirement the best feelings and the highest regard of every member of the Club. He was, however, glad also to be able to announce that Mr. Morland had kindly undertaken the duties of Treasurer to the Club. They had known him very well for a long time, and felt sure, from what they knew of his business capacity, that he would make an admirable Treasurer.

Mr. Vezey said he should like to thank the members for the kind way in which they had received the President's remarks with reference to himself. He need not say that he parted with the office of Treasurer with considerable regret. He could not say that he was absolutely in ill health, but he felt he must not disregard any longer the warnings of his medical attendant, especially as he had received several reminders which showed him it was wise to act upon the advice given. It was for this reason only that he was giving up the work. It had been his effort during the last eight years to get the finances of the Club into a healthy condition. The finances, he knew, were not everything; but it was without doubt a very important item in the management that they should be able to carry on the working of the Club without anxiety as to matters of finance, and this could only be done by careful attention to the details of the Treasurer's office, and to the keeping up of the number of their members. Mr. Morland had very kindly consented to take over the duties, and he was thoroughly capable of carrying them out efficiently. He hoped the members would be as kind to their new Treasurer as they had always been to their old one; and he would remind them that the opportunity for showing their appreciation would very soon occur, as subscriptions were due for the new year on January 1st, and these should be paid to Mr. Morland and not to himself.

Mr. Morland said he would use his best endeavours to keep

the finances in as good a state as Mr. Vezey left them; he should have a very good start, and hoped he might be able to carry on the work as well as his predecessor.

The President regretted they had no paper on the agenda for the evening, possibly owing to the near approach of the Christmas season, which frequently caused some falling off in their attendance. He wished them a very enjoyable time and a very happy and prosperous new year.

The Secretary announced that their next ordinary meeting would be held on January 19th, when members would be asked to make nominations for filling vacancies upon the committee; and they would also have at that meeting to elect an Auditor on behalf of the Club to audit the Treasurer's accounts for the year.

The meeting concluded with the usual conversazione.

Ordinary Meeting.—January 19th, 1900.

J. Tatham, Esq., M.A., M.D., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations were announced:—

"Proceedings of the Academy of Natural Sciences of Philadelphia"	From the Society.
"Journal of Applied Microscopy" ...	From the Publishers.
"Proceedings of the Bristol Naturalists' Society"	From the Society.
"Proceedings of the Literary and Philosophical Society of Manchester" ...	" " "
"Journal of the Royal Microscopical Society"	" " "
"The Botanical Gazette"	In exchange.
"La Nuova Notarisia"	"

The Secretary reminded the members that the next meeting would be the Annual Meeting of the Club, at which the Officers and Committee for the ensuing year would be elected.

The Committee had nominated the following members as officers :—

As President—Mr. George Massee.

As Vice-Presidents—Messrs. Tatham, Waller, Michael, and Nelson.

As Treasurer—Mr. Morland.

As Secretary—Mr. Karop.

As Foreign Secretary—Mr. Rousselet

As Reporter—Mr. Lewis.

As Librarian—Mr. Alpheus Smith.

As Curator—Mr. Browne.

As Editor—Mr. Scourfield.

Also as Auditor on behalf of the Committee—Mr. J. M. Allen.

In consequence of the changes which had been made there were six vacancies upon the committee to be filled on this occasion, and the members present were asked to nominate gentlemen to fill them.

The following nominations were then made :—

Mr. W. B. Stokes, proposed by Mr. Hughes, seconded by Mr. Swift.

Mr. C. Turner, proposed by Mr. Marshall, seconded by Mr. Lloyd.

Mr. J. M. Allen, proposed by Mr. Holder, seconded by Mr. Baker.

Mr. G. T. Harris, proposed by Mr. Turner, seconded by Mr. Muiron.

Mr. J. J. Vezey, proposed by Mr. West, seconded by Mr. Enock.

Mr. J. E. Ingpen, proposed by Mr. Dennis, seconded by Mr. Freeman.

And as Auditor on behalf of the members, Mr. Chapman was proposed by Mr. Marshall, seconded by Mr. Stokes.

Messrs. J. M. Allen and W. J. Chapman were, on the motion of the President, unanimously elected as Auditors.

Mr. Karop said every senior member, at least, would have heard with considerable regret of the death of Mr. W. T. Suffolk, Treasurer R.M.S., which occurred after a very short illness on the 1st inst. Mr. Suffolk was one of the very earliest members of the Quekett Club, having been elected in July 1865, and for some years took no inconsiderable part in furthering the aims for which it was primarily founded. In those days "How to

work with the Microscope" was ill understood by many, who had just become aware of the fact that a new world awaited those in a position to avail themselves of the services of this instrument. Himself a practised hand, and knowing the initial difficulties of the amateur student, Mr. Suffolk generously gave a series of practical demonstrations on the use of the microscope, the mysteries of preparing and mounting objects, and so forth—afterwards published in book form under the title of "Microscopic Manipulation,"—which were immensely appreciated by those who profited by his instructions. In the proceedings, briefly recorded in the earlier volumes of the Journal, may be found numerous instances of Mr. Suffolk's versatile knowledge of microscopy. He was also the author of a useful little work entitled "Spectrum Analysis as applied to Microscopical Observation."

Mr. Karop also read the report which had recently been drawn up by a special Committee of the Royal Microscopical Society on the subject of the standardisation of the substage and draw-tubes of microscopes. He was quite sure that the coming generation would be pleased when these resolutions took effect.

The President said he was delighted to find that this matter had been taken up by the Royal Microscopical Society. They had conferred a great boon upon microscopists generally by standardising the screw of the objectives, and if they succeeded in getting rid of what he found one of the greatest nuisances connected with the use of the microscope—that the eyepieces and substage fittings of different microscopes never fitted each other—they would confer a great benefit upon all.

Mr. Rousselet read a note on some Australian and other species of *Lacinularia*, six specimens being exhibited under microscopes in the room.

Mr. J. D. Hardy asked where these were found.

Mr. Rousselet said they were taken from a lagoon or large shallow lake, in which they were said to be very numerous.

Mr. Hardy thought that if this were a sheet of water liable to get dried up it would be rather a novel situation for *Lacinularia*.

The thanks of the meeting were voted to Mr. Rousselet for his communication.

A short paper by Mr. A. A. Merlin "On the Minute Structure of some Diatomaceæ from Corica Bay, Melbourne," was, in the author's absence, read by the Secretary. Mr. Karop said some

explanatory figures would make the observations easier to follow, and he had asked Mr. Merlin to send them.

Mr. Morland said Mr. Merlin had called attention to the difficulty in seeing some of these valves properly; he thought this was due to the method of mounting. If they were fixed first with gum this would prevent the medium from penetrating; and if, instead of mounting them upon the cover they were mounted on the slip, by introducing some small discs of definite thickness, the cover could be put down at a known distance from the slip and quite close enough to work with an immersion objective. If they tried to do this empirically they might either put the cover too close and thereby smash the diatom, or they might have it too far to be able to see it in focus.

Mr. Karop said that the excellent device mentioned by Mr. Morland was described in a back number of the Journal, vol. 5, p. 4, on "Mounting Selected Diatoms." It was a most useful suggestion.

The thanks of the Club were voted to Mr. Merlin for his interesting notes.

Mr. Karop made some remarks on the extreme degree of specialisation that is now evident in work on Cytology, and referred especially to a classification of the subject suggested by the late Dr. A. Graf (see Note, p. 315).

Mr. Karop further called attention to a remarkable paper which seemed to upset all the accepted ideas as to the process of fertilisation. In the "Comptes Rendus," cxxix. 1899, Professor Yves Delage, in recording his experiments on fertilisation, states that a non-nucleated fragment of the ovum of *Echinus*, *Dentalium*, or *Lanice* may be effectively fertilised, and give rise to a Pluteus, a Véliger, or a Trochophore respectively. Three larvæ may be reared from one ovum of a sea-urchin, and a normal blastula was obtained from a $\frac{1}{37}$th fragment. There is a cytoplasmic maturation distinct from the nuclear maturation. Non-nucleated fragments seem to be fertilised more readily than normal ova. It seems as if the essential fact of fertilisation were not the fusion of nuclei, but the union of a sperm-nucleus with a mass of ovum cytoplasm.

The President said they were very much obliged to their Hon. Secretary for his remarks in bringing these subjects before them, he was inclined to agree with him as to the feelings of

almost despair with which he contemplated what they might be coming to.

Mr. E. M. Nelson said that Mr. Edward Swan had sent three simple microscopes for exhibition which were of some interest. The lenses were of the form known as Coddingtons', although Coddington had nothing whatever to do with their invention. It was Wollaston who first suggested placing a diaphragm between two plano-convex lenses; Brewster subsequently improved this plan by making both the plano-convex lenses hemispheres, and afterwards he constructed the lens out of a solid sphere of glass, a groove being cut round its equator and filled with black paint for a diaphragm.

These lenses are mounted as "Compass" microscopes. The "Compass Microscope" was introduced as early as the year 1702, but the examples upon the table were designed by Mr. Gairdener, and made by Bryson of Edinburgh. Mr. Parsons has found them figured and described in "Carpenter on the Microscope," 1st Edition, p. 66, fig. 17. Mr. Newton Tomkins shortly afterwards designed an improved form which is figured and described in the "Transactions of the Microscopical Society of London," vol. vii., p. 57 (1859). Mr. Newton Tomkins was a prominent member of the Microscopical Society, and was instrumental in bringing Mr. Moginie's microscopes to public notice. He mentioned this because Moginie's microscopes may often be seen in use in this Club.

Meetings for the ensuing month were then announced, the Secretary again reminding the members that their next meeting would be the Annual Meeting of the Club.

Annual Meeting.—February 16th, 1900.

J. Tatham, M.A., M.D., F.R.M.S., President, in the Chair.

The Minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. E. E. Barker, Mr. R. E. Crossland, Mr. Thomas A. O'Donohoe, Mr. F. Tomlinson, and Mr. R. H. Barrett.

The following donations to the Club were announced:—

"Revista di Patalogia Vegetale," Nos. 7 and 8	In exchange.
"The Botanical Gazette"	In exchange.
"Proceedings of the Royal Society"	,, ,,
"Smithsonian Institution, Annual Report"	From the Institution.
"Report of the Biological Station at Plön"	,, ,, Director.
"Transactions of the American Microscopical Society"	In exchange.
"Peregallo's Catalogue of Diatomaceæ"	By subscription.
"Paper on a New Hand Microtome" (Italian)	From the Author, Dr. Fiori.

The Secretary then read the announcements of meetings, etc., for the ensuing month, and the business of the Annual Meeting was proceeded with.

The President having appointed Messrs. Swift and Sidwell to act as Scrutineers, the ballot for the election of Officers and Council was proceeded with, at the close of which it was reported that the following gentlemen had been duly elected:—

As President	George Massee, F.L.S.
,, *Vice-Presidents*	John Tatham, M.A., M.D., F.R.M.S. J. G. Waller, F.S.A. A. D. Michael, F.L.S., F.R.M.S. E. M. Nelson, F.R.M.S.
,, *Treasurer*	H. Morland.
,, *Secretary*	G. C. Karop, M.R.C.S., F.R.M.S.
,, *Foreign Secretary*	C. Rousselet, F.R.M.S.
,, *Reporter*	R. T. Lewis, F.R.M.S.
,, *Librarian*	Alpheus Smith.
,, *Curator*	E. T. Browne, B.A., F.R.M.S.
,, *Editor*	D. J. Scourfield.
To fill six vacancies on the Committee	J. Mason Allen, F.R.M.S. G. T. Harris. J. E. Ingpen, F.R.M.S. W. B. Stokes. C. Turner. J. J. Vezey, F.R.M.S.

The Secretary then read the thirty-fourth Annual Report (*see* pp. 350—353).

Mr. J. J. Vezey read the Treasurer's Balance-sheet for the year 1899, duly audited by Messrs. Allen and Chapman. He thought the figures presented needed no explanation. He would merely point out that their balance in hand this year was about £35 more than the amount carried forward on the previous occasion. Also that the sales of the Journal had been less by about £6, but, on the other hand, the cost of the Journal itself had been less.

He asked to be allowed to make a personal explanation, as it might at first sight seem very inconsistent for him, after giving up the office of Treasurer to the Club on the plea of ill-health and overwork, to almost immediately afterwards accept a similar position in connection with another society. The circumstances were, however, wholly unexpected, the death of Mr. Suffolk coming as a sudden blow, just at the time when the accounts of the R. M. S. should be prepared for audit. It happened that he was quite conversant with the details of these accounts, and, seeing the difficulty in which the Council had been suddenly placed, he felt it a duty to assist them in the emergency. He might add that the management of the accounts of the R. M. S. did not entail the same amount of work on the part of the Treasurer as was the case in connection with the Q. M. C., because in the former case a great deal of the work was done by the Assistant Secretary. He did not want the members of the Club to think that he had resigned his office because he was tired of the work. He could only assure them that his heart was as warm as ever towards the Club, and it would be his pleasure as much in the future as in the past to do all that he could to forward its interests.

Dr. Measures then moved "that the Report and Balance-sheet be received and adopted, and that they be printed as usual." He had very great pleasure in moving this because he was sure all would agree that the statements put before them were most satisfactory.

Mr. Spriggs having seconded the motion, it was put to the meeting by the Chairman and carried unanimously.

The President then read his Annual Address, at the conclusion of which he expressed his regret that Mr. Massee, who had that evening been elected as his successor, was unable to be present with them owing to an attack of influenza.

Mr. Western was sure the members must have listened to the

address with interest; he therefore had much pleasure in moving that their best thanks be given to the President for his address, and that he be asked to allow it to be printed in the Journal. He should also like to add to this that their thanks be also accorded to the President for his services to the Club during the past two years.

The motion having been seconded by Mr. Hardy, was put to the meeting by the mover and carried by acclamation.

The President thanked the members for the kind way in which they had received the address, and also for the hearty manner in which they had passed this vote of thanks. He should always be pleased to be of any service to the Club.

It was then moved by Mr. Marshall, seconded by Mr. Lloyd, and unanimously resolved, "that the best thanks of the Club be given to the Auditors and Scrutineers."

Mr. Groves said he had a pleasant duty to perform in proposing that a vote of thanks be given to the Committee and the Officers of the Club for their services during the past year. After hearing the report of the Committee and the financial statement of the Treasurer, it must be obvious to all that they owed a debt of gratitude to all who had been concerned in so ably carrying on the management of their affairs during the year. The services of their Treasurer had already been alluded to, and no words from him were needed to increase their sense of indebtedness. They had all felt what a great loss they suffered by having to accept his resignation, for they all knew something of the efficient manner in which he had worked, and how large a measure of the present prosperity of the Club was due to his efforts, and to his genial manner in carrying on the work of his particular department. As regarded Mr. Nelson, they were greatly indebted to him for his services in connection with the Journal, and very much regretted that they were about to lose them. Their Secretary's work was so well known that he could add nothing to what had been said; he was always working so actively, and always so ready to push forward the interests of the Club in general. Messrs. Lewis, Smith, Rousselet, and Browne, were all well entitled to their most hearty thanks for what they had done, and the Committee, as well as their Vice-Presidents, must also be heartily thanked for their useful services.

The motion, having been seconded by Mr. Traviss, was put to the meeting by the President and carried with applause.

Mr. Karop, in responding, thanked the members on behalf of himself and his colleagues for their vote of thanks. For himself, he could only say that as each year came round he felt that having been in office since 1883, he had perhaps held it long enough, and though he should not resign unless they wished it, he felt the time had come when he ought to have a little help. So long, however, as he remained, he should always—as would each of the other officers—do what he could to further the interests of the Quekett Club.

The proceedings then terminated with the usual Conversazione.

OBJECTS EXHIBITED, WITH NOTES.

February 3rd, 1899.

Mr. A. L. Still: A mounted colony of *Obelia* (*Obelaria*) *gelatinosa*, Hincks, taken at Burry Holmes, Glamorgan, in April 1898. The method employed for fixing consists in adding a few drops of a 20 per cent. solution of cocaine to the bottle containing the hydroids, and, when fully extended, gently stirring in two or three drops of Osmic Acid (1 per cent.). In the case of Obelia the bottle should be placed in sunlight for an hour, while the cocaine is acting. Some hydroids, like Plumularia, extend more readily, a few minutes sufficing. After killing, the specimen should be placed in clean sea-water, and enough formalin added to make the whole roughly a 2 per cent. solution.

March 3rd, 1899.

Mr. A. L. Still: A specimen of *Limnias cornuella* found at Henfield, Sussex, on February 28th, 1899. This species has not hitherto been found in this country except in the *Victoria regia* tank at the Royal Botanic Gardens.

Mr. G. T. Harris: *Thuricola operculata*, Gruber, from Epping Forest. Saville Kent, in his "Manual of the Infusoria," states that this species has only been recorded by Gruber. *Thuricola operculata* differs from *T. valvata* principally in having a well-developed pedicle, this being in some specimens I have examined of extraordinary length, though it is a very variable feature.

Mr. R. Macer: A specimen of *Raphignathus falcatus*, Hodge. Although belonging to the Halacaridæ, a family of marine mites, it was found in the fresh-water canal at Weybridge, Surrey, in the autumn of 1898. There is a note and figure of this species in *Science Gossip*, March 1899, p. 293. A noteworthy feature is the distinct median eye.

Mr. A. Earland: A collection of Radiolaria (fossil forms) from Springfield, Barbados. Illustrating sixty of the more typical forms.

April 7th, 1899.

Mr. H. Morland: A stained leaf of *Pistia stratiotes*, a West Indian pond-weed, showing the raphides and sphæraphides in the cells.

Mr. A. W. Dennis: A specimen of *Prototrichia flagellifera* (Mycetozoa), showing the spores and the attachment of the capillitium to the wall of the sporangium.

MAY 5TH, 1899.

Mr. C. Rousselet: *Apsilus bucinedax*, a rotifer not previously seen in Britain. Found by Mr. Bolton, of Birmingham, on some water plants imported from abroad.

MAY 19TH, 1899.

Mr. W. R. Traviss: A section of quartz, with cavities containing a liquid and a gas.

Mr. A. Earland: A group of Foraminifera from Trondhjem Fjord, Norway. Typical sub-Arctic species selected from anchor mud obtained by Mr. J. T. Holder in 1898.

JUNE 2ND, 1899.

Mr. C. Rousselet: *Melicerta ringens*, with *green* tubes produced under natural conditions.

Mr. H. Morland: *Eunotia robusta*, a fresh-water diatom from Lafayette Mountain Lake, showing front and side views.

JULY 7TH, 1899.

Mr. C. Sidwell: *Ceriodaphnia quadrangula*, from Windermere. This Entomostracan was first recorded as British by Mr. Scourfield in 1892. It is figured in the Club's Journal for that year (Vol. V., Pl. 4).

Mr. H. Morland: *Surirella ovalis*, Breb. Frustule and valves, normal and abnormal, *i.e.*, with irregular outline.

AUGUST 18TH, 1899.

Mr. D. J. Scourfield and Mr. C. Sidwell: *Chlamydococcus nivalis* ("Red Snow"), from the Windacher Glacier, Tyrol. Collected by Mr. Scourfield on the 9th instant.

NOVEMBER 3RD, 1899.

Mr. C. Rousselet: A mounted colony of *Lacinularia pedunculata*, from Victoria, Australia. Collected and preserved by Mr. John Shephard.

Mr. H. Morland: *Navicula perrotetti*, Grun, from Nsessi, Lake Nyanza; the specimen shows a monstrosity in the way of a "gridiron" framework under the outer surface of the valve.

November 17th, 1899.

Mr. A. L. Still: A longitudinal section of the phloem of a species of *Bignonia* prepared to show the sieve-plates.

Mr. A. Earland: A social Radiolarian, *Sphærozoum punctatum*, showing a number of individuals imbedded in a joint calymma.

Mr. A. E. Hilton: Head of Burnet Moth, *Zygæna filipendulæ*, remarkable for the form of the antennæ. Mounted in glycerine.

December 1st, 1899.

Mr. H. Morland: Frustules and valves (various views) of *Solium exsculptum* from Cementstein from Mors Island in the Limfjord, Jutland, Denmark.

Mr. A. Earland: Specimens of *Hippocrepina indivisa*, Parker, from Davis Straits, Greenland, thirty fathoms. The genus *Hippocrepina* contains but this one species, which is of very rare occurrence, and confined to the Arctic seas. It has a test shaped like a carrot, with a single internal chamber. Aperture at the broad end, usually a curved slit with a raised rim, but in these specimens a simple round orifice.

December 15th, 1899.

Mr. H. E. Freeman: *Argas reflexus* from Canterbury Cathedral, showing natural surface of the skin. Some remarks about the discovery of this species of tick in England are given in the last number of the Club's Journal (November), pp. 226-7.

Mr. A. Earland: A new species of *Discorbina* from Davis Straits, thirty fathoms. Its nearest relative is *D. parisiensis* of d'Orbigny, from which it differs in its extremely large size, and especially in the secondary structure of the stellate flakes filling in the concavity of the inferior surface.

January 5th, 1900.

Mr. C. Rousselet: A mounted specimen of *Stephanoceros eichhorni*.

Mr. A. E. Hilton: Longitudinal section of the growing tip of *Pinus*. Showing karyokinetic division of cells in the developing tissue.

Mr. A. Earland: Radiolarian ooze from the Central Pacific, 2450 fathoms. Decalcified.

Mr. H. Morland: Front and side views of valve of *Graya argonauta*, Br. and Grove, from San Redondo Beach, S. California. This species is occasionally found in various deposits. It was first described in 1892, but the present slide was mounted in 1890.

JANUARY 19TH, 1900.

Mr. C. F. Rousselet: Mounted specimens of six species of *Lacinularia*, viz. *L. socialis*, *L. pedunculata*, *L. natans*, *L. reticulata*, *L. striolata*, and *L. elliptica*, all except the first from Victoria, Australia. (See Note p. 313.)

FEBRUARY 2ND, 1900.

Mr. E. M. Nelson: Tubercle Bacilli shown with Wollaston doublet.

Mr. J. T. Holder: Section through the tentacular fringe bordering the inhalent aperture of the Fresh-water Mussel (*Anodonta cygnea*).

Mr. H. Morland: Front and side views of *Actinodiscus barbadensis*, Greville, from Jackson's Paddock, Oamaru, New Zealand, showing the depth of the undulations.

Mr. A. Earland: Three forms of *Frondicularia alata*, d'Orbigny, from Cape Cruz, Cuba, 170 fathoms. (1) Adult normal shell; (2) young normal shell; (3) young shell of "flabelline" variety. In the latter the early chambers are arranged spirally instead of in a straight line as in the normal forms. The normal shells are megalospheric, *i.e.*, the primordial chamber is of large size, whereas the flabelline variety is microspheric. This may possibly be a sexual distinction.

Mr. J. B. Scriven: Two sections of compound eye of Blowfly. (1) Trachea passing through limitary membrane of retina. (2) Rhabdomes of dioptron passing through the limitary membrane. These two sections show the rhabdomes and tracheæ of the dioptron passing together through the outer limitary membrane of the retina, the same opening in this membrane being often found occupied by one trachea and one rhabdome. The tracheæ pass more obliquely than the rhabdomes; the fibres of the latter distinctly join those of the retina.

FEBRUARY 16TH, 1900.

Mr. C. Rousselet: Mounted specimen of *Leptodora hyalina*, from the Regent's Canal, Regent's Park. It was taken in 1897, this being, so far as known, the first record of this remarkable hyaline Water-flea anywhere near London. A few more specimens were taken at the same place in 1898. Figures and descriptions of this rare species will be found in the *J.R.M.S.* and the "Midland Naturalist" for 1879, the year in which it was first discovered in England.

THIRTY-FOURTH ANNUAL REPORT.

Your Committee is again able to report favourably on the affairs of the Club during the past year.

In the twelve months ending December 1899 thirty-eight new members were elected, being four in excess of the previous year, and the highest in number since 1892. On the other hand, seven were lost by resignation, eight removed for non-payment, and eight by death. Chief amongst the latter was Mr. J. W. Reed, a member since 1877, and who in various ways took the warmest interest in the Club. He was a member of the Committee, and constant in his attendance thereon and at the meetings; he introduced many recruits to our ranks, and it was owing to Mr. Reed's good offices that the Club obtained the services of an excellent amateur band at its special Exhibition nights, which went far in promoting the success of these gatherings. Altogether, the loss of Mr. Reed will be severely felt and sincerely regretted by his many friends. The total membership at the date of the Report is 343.

The interest in the proceedings has continued unabated, and the meetings have been, as usual, well attended; but there was some little falling off in the number of papers submitted. The following is a list of the more important:—

Jan.	On a method of preparing Type Slides of Foraminifera	Mr. Bryce Scott.
,,	On the winter egg of *Leydigia acanthocercoides*	Mr. Scourfield.
Feb.	The President's Address	Dr. Tatham.
Mar.	On *Trochosphæra solstitialis*	Mr. Rousselet.
,,	On a new species of *Atax*	Mr. Soar.
Apr.	On some Australian Ticks	Mr. Lewis.
June.	Early Memories of the Q.M.C. ...	Dr. Cooke.
Oct.	On an undescribed British Sponge ..	Mr. Waller.
Nov.	On the Radiolaria	Mr. Earland.

At the March meeting Mr. Lewis Wright gave a demonstration

with the lantern microscope, and exhibited many beautiful preparations on the screen; and at the May meeting Mr. F. Enock delivered a lecture on the life history of the Tiger-beetle, illustrated by a series of charming and lifelike lantern slides. Both exhibitions were highly appreciated, and your Committee desires to express its thanks to these gentlemen and to the other members who have read papers before the Club.

A small number only of new instruments and accessories were brought to notice, descriptions of which will be found in the proceedings.

As the members who were associated with the foundation and early history of the Club are yearly becoming fewer, the Committee felt that if any authentic account of this was to be put on record it was very desirable it should be done without further delay. Accordingly Dr. M. C. Cooke was requested to undertake the task, as the organisation and rapid success of the Club were mainly due to his efforts; and he most kindly complied. In the "Early Memories of the Q.M.C." we now possess a true narrative of the events which brought the Club into existence; and the best thanks of the Committee are due and are hereby offered to Dr. Cooke for the duty he willingly accepted and so worthily fulfilled.

The following is a list of the books, etc., added to the Library by donation, exchange, or purchase:—

G. Massee's "Text-Book of Plant Diseases caused by Cryptogamic Parasites" ...	Presented.
E. J. Spitta's "Photo-Micrography"	The Author.
Dr. Braithwaite's "British Moss Flora," Part XIX....	" "
Buckler's "Larvæ of the British Butterflies and Moths," Part VIII.	By subscription.
"Journal of the Royal Microscopical Society"	In exchange.
"Proceedings of the Royal Society"	" "
"Journal of Applied Microscopy"	" "
"American Botanical Gazette"	" "
"Proceedings of the Geologists' Association"...	" "
"La Nuova Notarisia"	" "
"Quarterly Journal of Microscopical Science"	Purchased.
"Annals and Magazine of Natural History"	"
Proceedings of various Societies	In exchange.

The additions to the Cabinet were few, and require no special comment. Mr. Mottram's proposed gift of two hundred slides of Diatoms, mounted by Professor H. L. Smith, has been held over until such time as the donor is able to give attention to the matter.

It is with feelings of the most profound regret that your Committee announces the retirement of the Hon. Treasurer, made still greater by the fact that it is due to failing health. For eight years Mr. Vezey has so managed and controlled the financial affairs of the Club that never in its history have they stood on such a sound basis as at present; his unvarying courtesy and kindness have made him universally respected and esteemed, and his fertility of resource and able counsel have materially lightened the work of the Committee and officers. On behalf of the whole body of members the Committee beg to tender him its warmest and most sincere thanks for his long-continued and masterly services; and, further, it hopes that abstention from his many self-imposed labours, both here and elsewhere, will largely alleviate or remove the cause which has compelled him to resign his post.

The Committee is happy to state that Mr. Henry Morland has kindly consented to take over the Treasurership; and, from his long connection with and lively interest in the Club, it is quite confident he will carry it on with ability and success.

The usual Journals have been published and sent to all members whose subscriptions are not in arrear.

The Committee has to deplore the resignation of the Hon. Editor, Mr. Nelson, who has performed the duties of this office most efficiently since the death of Mr. Hailes in 1892; and here again the relinquishment is unhappily necessitated by indisposition.

The manifold and considerable services rendered to the Quekett Club by Mr. Nelson are known to and appreciated by all; indeed, it is not hyperbole to say that much of the prestige it has acquired is due to the investigations and researches in microscopy, and physical optics in connection therewith, which he has so freely placed at its disposal during many years. The Committee begs Mr. Nelson to accept its heartiest thanks for all his benefactions, and it is certain he will take with him in his retirement the cordial good wishes of his friends and admirers—

in other words, of every member of the Club—for his complete restoration to health and activity.

The Committee has been fortunate in securing Mr. D. J. Scourfield as Editor, and, knowing the excellent work he has done, it is certain that in his hands the Journal will fully maintain the position it has won.

The financial position of the Club is thoroughly sound, and the balance in hand at the end of last year exceeds former totals for at least a decade. It is almost unnecessary to say that this state of affairs is very largely indeed due to the energy of the late Treasurer; but the hearty thanks of the Committee are also owing to Mr. Rousselet for the able manner in which he has managed the advertising arrangements in the Journal and the revenue accruing therefrom. As the present is a favourable time for purchasing stock, the Committee has felt justified in adding £100 Consols to the Club's investment.

The Committee desires to thank the officers for their invaluable services, and also the members of the Excursions Sub-committee.

In spite of the severe losses the Club has sustained amongst its Executive, the Committee is full of hope that its career may remain unimpaired, and that in the future, as in the past, occasional inevitable difficulties will be resolutely met and overcome. But every one who has its interests at heart must see that no effort is spared to enlarge its membership as well as to promote and foster the aims for which it was founded, and, knowing the vitality manifestly existing, the Committee cannot doubt that the Club will continue to flourish.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1899.

Dr.	£	s.	d.	Cr.	£	s.	d.
To balance from 1898	198	19	10	By Rent of Rooms and Bookcases ...	54	12	0
,, Subscriptions received in 1899 ...	161	10	0	,, Expenses of Journal	86	1	10
,, Dividends on Investments	6	10	8	,, Postage	5	1	7
,, Sales of Journal	15	3	5	,, Printing and Stationery	5	3	10
,, Sales of Reprints	0	5	0	,, Attendance	6	0	0
,, Sales of Catalogues	0	7	0	,, Books, etc., purchased...	4	19	4
,, Receipts for Advertisements	15	15	0	,, Petty Expenses	3	6	0
				,, Balance in hand...	233	6	4
	£398	10	11		£398	10	11

INVESTMENTS.

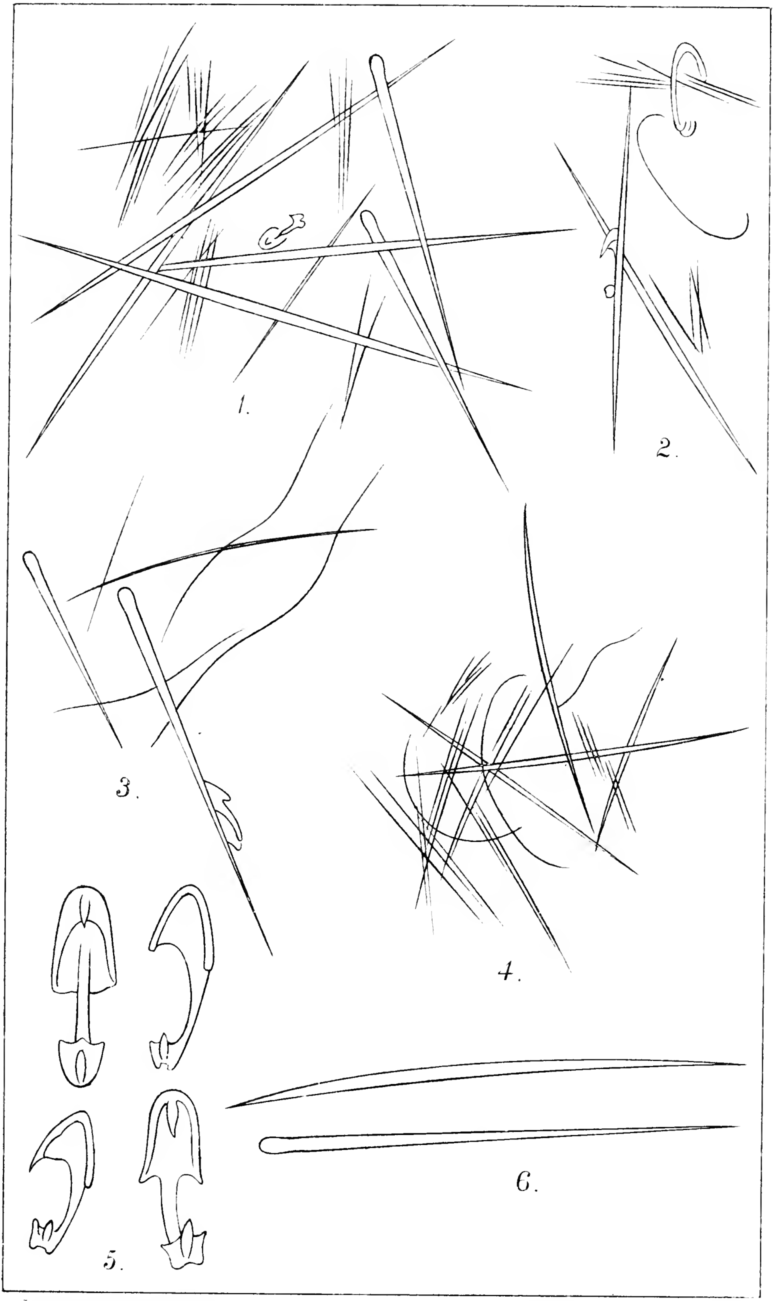
	£	s.	d.
Moneys Invested in £2 15s. Consols	£200	0	0
,, ,, ,, £2 10s. Metropolitan Stock	49	5	2
	£249	5	2

We have examined the above Statement of Income and Expenditure, and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

January 22nd, 1900.

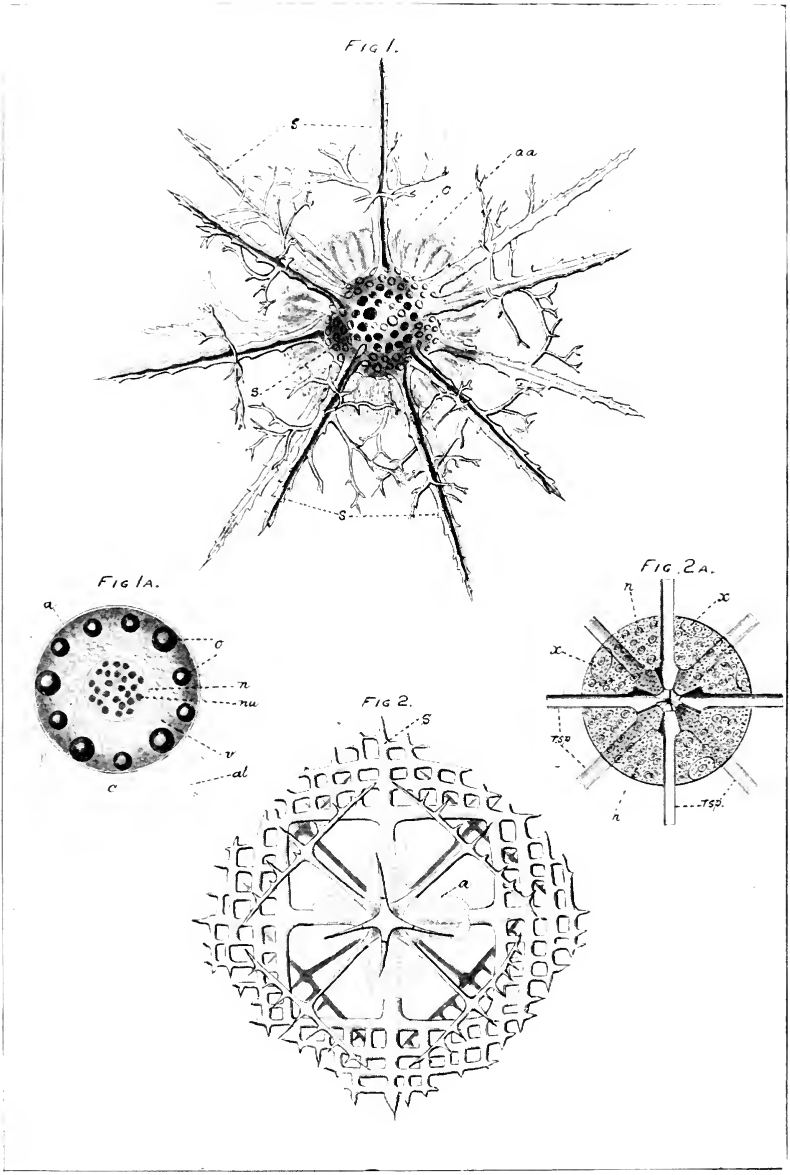
J. J. VEZEY, *Hon. Treasurer.*

J. MASON ALLEN,
W. INGRAM CHAPMAN, } *Auditors.*



J. L. Walker ad nat del. Bale & Danielsson. Ltd lith.

RAPHIODESMA AFFINIS n. sp.



TYPICAL RADIOLARIA.
(Spumellaria and Acantharia).

FIG 3.

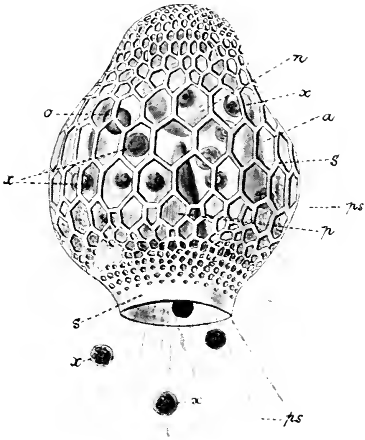


FIG 3A.

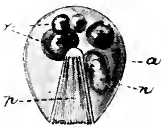


FIG 4A.

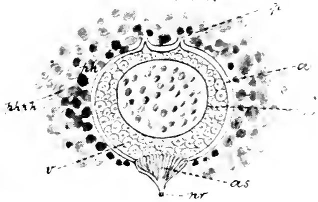
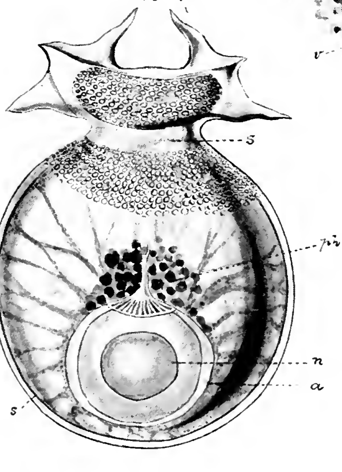
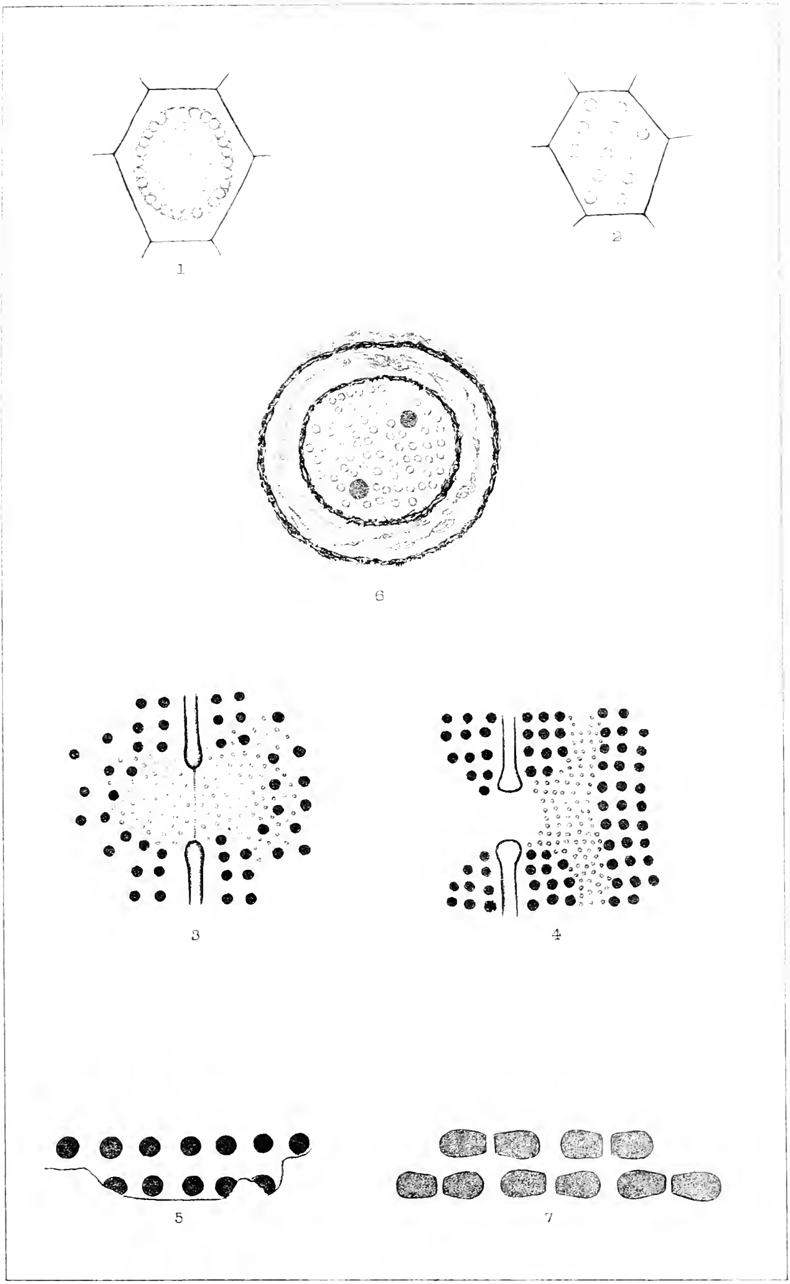


FIG 4.



TYPICAL RADIOLARIA.
(Nassellaria and Phæodaria).



A. A. Merlin del. West, Newman lith.

Minute Diatom Structure.

The Anatomy of *Dicranotænia Coronula.*

By T. B. Rosseter, F.R.M.S.

(*Read April 20th*, 1900.)

Plates 18 and 19.

Part 1.—Description and Structure of the Strobila.

Dicranotœnia Coronula (Dujardin 1845), Railliet 1892, Rosseter 1881-1900.

(*Tœnia coronula* Duj. 1845).

No mention is made of this tape-worm in the writings of the older naturalists and helminthologists, either by Linnæus, Pallas, Goeze or Rudolphi, until in the year 1845 it was discovered by Dujardin the French helminthologist and Professor of Zoology at Rennes in France, on more than one occasion, as being parasitic in the alimentary canal of the Duck. Which of the species of the Anatinæ he does not state, but I should think, in all probability, it would be *Anas boschas dom.* Since then it has been found by Von Siebold (1854) in *Glaucionetta clangula*, commune with *Tœnia lœvis*; by Krabbe in Zealand (1867-68) in *Anas boschas dom.;* by Von Willemoes-Suhm (1882) at Munich in *Anas boschas fera;* by Railliet (1892) at Alfort in the same species, and by myself (1881-97) at Canterbury, England, also in *Anas boschas dom.* This latter is the only recorded instance and report we have of its discovery in this country.

All the above-mentioned helminthologists have merely given their views, and based their descriptive text on the external characteristics of this worm. Under such circumstances, and having the material to hand, I determined to restudy the anatomy of this avian tape-worm, more especially the organs of generation. The notes and the observations written by me in 1891 on the "Muscular Structure of the Scolex" (*International Journal of Microscopy*) will be embodied in this paper; together with such new material as has been acquired during my investigation of this organ of prehension.

The specimens of this tape-worm used in my former investigations were found among the fæces of a Duck; but those which have been used in the preparation of this work were produced by my feeding ducks with the Cysticercoids of this species, it being one of four species of Cysticercoids with which I successfully infected ducks for the special purpose of producing the mature worm (see "On Experimental Infection of Ducks with *Cysticercus coronulâ*, etc.," *Journ. Q. M. C.*, Ser. 2, vol. 6, 1897, p. 397). Of the thirteen known species of Tænia,—not including the new genus and species *Echinocotyle Rosseteri* 1891, and the doubtful species *Tænia Krabbei* Kowalewski, 1895,—which make the Anserinæ and the Anatinæ their final hosts, *Dicranotænia coronula* is the most common, and in this respect offers facilities for investigations and study; but, owing to the density and opacity of the parenchymatous tissue, and the peculiar muscular structure of which the proglottides are composed, it is a difficult subject to investigate so as to form an accurate diagnosis of the position and formation of the male and female generative organs. This difficulty was experienced and has been commented on by such workers as Leuckart and Moniez, in their investigations of the larger mammalian tape-worms; thus it is easy to comprehend the difficulties to be contended with in the preparation, staining, section-cutting, and mounting so necessary for the investigation of these comparatively small avian tape-worms. True, much good work can be done by maceration and teasing, and I have obtained a deal of information in this way; but these methods, the latter more especially, not only require a good supply of material but a steady hand, a quick perceptive eye, and, what is above all, a deal of patience.

Dicranotænia coronula is found in the lower portion of the intestine, in close proximity to the rectum, and it is waste of time to seek for it in the duodenum, the usual locality of tape-worms, in the mucous-membrane of which they bury their scolices, and attach themselves by their hooks and suckers.

As a basis for a description of this worm we must take that given by Dujardin.

"Strobila long de 40 à 140 mm. (?), large de 1·5 mm. à 2 mm. en arrière, insensiblement aminci, en avant, formé d'un très grand nombre d'articles très courts; tête large de 0·20 mm. à

0·22 mm., presque rhomboidale, avec les ventouses anguleuses, saillantes, irrégulières, large de 0·066 mm. à 0·09 mm.; trompe épaisse, large de 0·09 mm., longue de 0·06 mm., entourée d'une couronne de dix-huit à vingt-quatre petits crochets long de 0·009 mm. à 0·014 mm., qui sépare une partie terminale hémisphérique d'une partie moyenne, élargie et gonflée tout autour."

I have omitted his description of the male and female organs, which I shall quote under their respective headings.

This external description, together with his sketch of one of the hooks from the rostellum, the only illustration he gives us of this tape-worm, is amply sufficient to make it recognisable when met with either in the alimentary canal of the Duck, or amongst the extruded fæces.

Two specimens of this tape-worm, taken from the alimentary canal of the Duck experimented on, were selected for investigation: they measured respectively 75·7 mm. and 78·9 mm. long; but then they had previously shed their uterine proglottides, consequently they were much abridged. The width, that is from the proximal to the distal lateral border of the terminal proglottis, of the former was 1·700 mm., and the latter 2·194 mm., and the length in either case 0·176 mm. At the commencing formation of the segmented strobila the proglottides are very small, being but 0·135 mm. and 0·017 mm. long.

The length of the neck, which is unsegmented, is approximately 0·690 mm.; I say approximately, because the creature has the faculty of contracting or attenuating the neck, and in this respect it is somewhat misleading, as in some specimens when so contracted the neck is thickened and the lateral borders show the segmented furrows of the future proglottides. The scolex, or head, is rhomboidal; and when the rostellum is inverted has a diameter of 0·202 mm.; but when it is everted, the scolex is diminished by 0·04 mm. The suckers are four stout elastic muscular bodies. At times they swell out and stand up prominently above the scolex at an elevation of 0·017 mm.; at other times sinking down to a flat plane surface. They have, as Dujardin describes them, an irregular or angular appearance, and when disassociated from the scolex they have an equatorial diameter of 0·057 mm.

The rostrum is an oval muscular bulb; it bears a crown

or circlet of 18 to 24 (the latter is the more constant) pitchfork-shaped hooks. The under or posterior root is blunted or club-shaped, whilst the anterior is a short, sharply curved hook; the posterior root is 0·007 mm. long, and the whole length of the hook is 0·013 mm. The anterior portion of these hooks in fresh or well-preserved specimens stands boldly out from the periphery of the crown at a right angle from the convexity of the bulb, like spikes on a "cheval-de-frise," whilst the posterior root is buried deeply in the muscular bulb. The bulb is 0·038 mm. long and 0·068 mm. broad. It is composed of a dense mass of circular and very fine longitudinal muscles. The apical portion of the rostrum is a pyriform aggregated mass of cellular tissue, enclosed by a structureless membrane, and encircled by a series of broad retractor muscles; the whole mass, inclusive of the bulb, being 0·074 mm. long. In a previous work on the scolex of this tape-worm I stated that "there was no cavity, but that the hard muscular bulb pressed down on invagination the parenchymatous tissue, etc." This is somewhat erroneous, for the disassociation of the rostellum from the surrounding tissue by maceration and teasing, and also by pressure under a cover-glass, reveals its structural formation and mechanism.

In the centre of the crown of the scolex is an orifice (Fig. 1 *a*), which varies in its formation from a circle to an oval, according as the scolex is contracted or expanded; this leads into a deep ovate cavity or cyst which is lined by an endothelial membrane, its exterior being convex; it has a depth of 0·169 mm. and its equatorial diameter is 0·101 mm., and within this ovular cavity or cyst, when inverted, is the rostellum with its bulb. It is held in position in the centre of the cavity by its protractor and retractor muscles, and also by a strong muscular elastic footstalk, which is firmly attached to the membraneous lining at the basal centre of the cavity; and thus it, the rostellum, is kept in a concentric position within the cavity.

The retractor muscles (Fig. 1 *b*) spring from the endothelial wall of the lower third of the cavity. Spreading themselves over the surface of the rostellum, they find their termination, or seat of attachment, at the edge of the circlet or crown of hooks, close under their posterior roots; and on inversion they hang down within the cavity, like a festoon of ribbons. These muscles, although not performing the same functions as the broad

longitudinal muscles of the neck and strobila, yet anastomose with these longitudinal muscles at the base of the cyst.

The protractor muscles (Fig. 1 *c*), are a series of muscular fascicles placed equidistantly on the upper periphery or base of the bulb, at the back of the circlet or crown of hooks. Each fascicle is composed of numerous fine elastic fibres which form a cone in the centre of the annule or orifice of the cavity. From the endoderm of the zonal periphery of the orifice springs a plexus of muscle fibres (Fig. 1 *a*), each one coalescing with the fascicles of protractor muscles either at, or in close proximity to, their apex. These angular protractor muscles, together with the plexus, are only discernible when the rostellum is deeply inverted within the cavity,* when the fascicles are stretched to their fullest tension, and the plexus too has a downward acute angle. On the eversion of the rostellum with its bulb, the tension of these fascicles of protractor muscles is completely relaxed; and the rostellum, on emerging from the orifice, draws up the plexus over its bulb, where, in prepared specimens, these muscles are then seen coursing down longitudinally between the interspaces of the hooks.

The disassociation of the suckers by maceration enables us to trace those muscles which elevate or depress them, so as to fix or detach the scolex to the mucous membrane of the intestine. From the back of the suckers, these muscles in a radiate form pass through the surrounding tissue, and are attached in the upper third in the region of the orifice to the ectothelial cuticle of the rostellum cyst; and thus their contractility, and expansion, or in other words their fixative power, is subservient to the retractor and protractor muscles.

The structural composition of the Strobila is of a very complex character, and this complexity increases in density by the growth of the proglottis, thus obscuring, and rendering somewhat undefinable, the generative organs as they approach maturity. This structural density also increases the tenacity of the proglottis when it becomes a uterine sac for the protection and development of the oncospheres. Each sexual proglottis is composed of 1st, a cuticle 0·005 mm. thick,—this is, according to Linstow, 0·0028 mm. in excess of the thickness of the cuticle of *Tænia depressa*; 2nd,

* It is usually inverted to a depth of 0·050 mm. below the annule or orifice.

a fine layer of transverse muscle fibre mingled with cellular tissue; 3rd, an epithelial layer of spindle cells; 4th, a layer of broad bundles of longitudinal muscles, and lastly a wide band of ring muscles, which run completely round the proglottis, thus forming its endothelium; and then follows the parenchymatous tissue of the cavity in which the organs of generation are embedded. This last layer of ring muscles thickens considerably at the boundary or rim of the proglottis, its density causing it to appear as a dark band. It has a thickness of 0·001 mm.

The longitudinal muscles are broad smooth muscles, commencing in the scolex, where, as I have said above, they anastomose with the retractor muscles. Through the narrow neck and early formed segments they aggregrate together as if forming a solid circular band of muscle fibres; but as the segments develop they disintegrate, and spread themselves out laterally, both dorsally and ventrally, on each proglottis; and to a casual observer they would give the impression that they run continuously through the whole length of the strobila. This would be an erroneous interpretation, and it is only in prepared sections, and by the aid of a high power that an accurate diagnosis of their structural composition, and mode of attaching each proglottis can be demonstrated. The method of attachment so as to facilitate the separation of the ripe or "uterine" proglottides from the strobila is by the aid of "spindle-cells." Leuckart held this view in connexion with the musculature of *Tœnia saginata*, and although I am unacquainted, experimentally, with the anatomy of *T. saginata*, yet I am in a position to say, having made it my especial study, that this method of prolongation of the longitudinal muscles by the aid of spindle cells in the mammalian tape-worms, of which *T. saginata* is made the type, is equally the same in this representative, viz., *Dicranotœnia coronula*, of the avian tape-worms. From my prepared specimens of this tape-worm I deduce the following conclusions: Two spindle-cells (Fig. 2 *a*) separate themselves one on either side of the longitudinal muscle; these cells are thus outgrowths from the parent muscle. They are bi-polar; the anterior pole or thread being but an elongation of the cell proper, remains attached to the muscle; whilst, from the posterior fine polar fibre, the continuing longitudinal muscle is evolved.

These longitudinal muscles, as also the retractor muscle fibres,

are formed during the development of the scolex in the cysticercoid stage. If the cysticercus when taken from its nurse is treated with simmering nitric acid, the encysted scolex escapes through the eversion of the invaginated portion of the cyst; by this process in mature scolices they appear like fine threads.

Irrespective of the muscular structure already described, each proglottis is furnished with a series of trellis-work muscles running from the distal to the proximal lateral border. They are smooth muscle fibres, and have a diameter of 0·003 mm. (Fig. 3). They are deeply stained by the action of hæmatoxylin in chromic-acid specimens. The porose muscles have an angle of 30° and the aporose an angle of 60°. I have not been able to trace any connection between these muscles by the aid of spindle-cells from one proglottis to the other, consequently I look upon them as independent muscle fibres. It is this muscular trellis-work which adds so much to the density and tenacity of the sexually mature portion of the strobila, for it is not developed in the earlier segments.

Placed equidistantly round the basal portion of the rostellum, but imbedded in the tissue, are four palmate ganglionic bodies. Each ganglion is split up into five digital parts, with a commissure between each digit. The lower portion of each ganglion tapers to a thin cord. Each of these cords attaches itself to an annule, or ring, which makes a circumference of the interior of the scolex, but does not impinge on either of the suckers. This ring *in situ* appears to be a homogeneous mass, but is really made up of four annular cords. From these rings proceed, posteriorly, as outgrowths, four very fine cords, which proceed downwards, both ventrally and dorsally, near the lateral margin, the whole length of the strobila. As they emerge from the scolex, and through the neck and early segments of the strobila, they are straight narrow cords; but with the growth of the proglottis they develop, become broader, and undulatory or wavy in their character (Fig. 20). They do not lose their individuality in the sexually mature proglottides, but in the uterine segments they are untraceable. This wavy condition coincides with Von Linstow's wavy nerve-cords of *Tænia depressa*; and, although I originally thought that these palmate bodies were "retractor muscles," and described them as such, I am now convinced by

again examining my specimens, that these wavy, undulating cords are nerve cords. Thus their connection with the annular rings, and consequently the palmate bodies, points to the fact that the latter are ganglionic bodies—supra-œsophageal ganglia—and that the annular cords are a series of nerve-centres. This conclusion is more accentuated because by careful focussing ganglionic thickenings or processes are traceable on these annules, but their terminative fine nerve cords are untraceable in the surrounding tissue, although I feel convinced they proceed to the muscular structure of the suckers. A much finer nerve cord proceeds from the lateral cords, and runs dorso-ventrally on the posterior margin of the proglottis.

The secretory vessels have defied all my attempts to satisfactorily elucidate them, or trace their ramifications, excepting occasionally in isolated segments, but this has been of such an unsatisfactory character that I pass them over, reluctantly, without further comment.

The chalk corpuscles (Fig. 4) are either globular or ovate. In the former case they have a diameter of 0·003, and in the latter of 0·007 mm. The whole strobila is thickly studded with them, but they are more conspicuous in the neck and early segments.

Part 2.—The Male and Female Generative Organs.

Dujardin's description of the male genital organs runs thus: "Orifices génitaux unilateraux; penis long de 0·06 mm. à 0·12 mm., large de 0·03 à 0·053 mm., mais pouvant se gonfler jusqu'à 0·08 mm., formé d'un large tube membraneux, hérissé de très petites épines, et pouvant rentrer par invagination."

By this it will be seen that the only descriptive portion of the male genital tract given by Dujardin is that which we now designate as the "Cirrus" and "Cirrus-pouch." Krabbe's * description is even more brief: "Aperturæ genitalum secundæ; Longit penis 0·11 mm., latit 0·041 mm." Railliet's work on this tape-worm I am unacquainted with, but Dr. Stiles † says that the adult form of this Tænia is very *superficially* described, and he queries the internal anatomy. I am led to the conclusion, by these remarks of Dr. Stiles, that Railliet's description is

* Bidrag til Kundskab om fuglens Baendelorme, 1869.

† Tape-worms of Poultry. Washington, U.S.A., 1896.

external, and does not deal with the internal *topographical anatomy* of this helminth.

Male Organs.

The genital cloaca with its genital pores is unilateral and dextral. It is an elongated cavity. It is situated on the extreme margin of the proglottis, at the anterior apical end, and is partially overlapped by the preceding segment. Its shape is dependent in a great measure on the muscular contractility and expansion of the strobila; and its contour, together with the cavity, is not obliterated in the uterine segment. Its long diameter is 0·07 mm., and its cross diameter 0·023; its depth to the male orifice is 0·04 mm., and to the female 0·047 mm.

The male genital apparatus consists of the cirrus and cirrus-pouch, the vesicula seminalis, and the testicular organ with its vas-deferens (Fig. 5 A).

The male genital tract is situated in the anterior portion of the proglottis; it occupies two-thirds of the whole length of it, and runs somewhat dorsally and ventrally.

The testis is not, as in *Tænia depressa*, scattered over the interior of the proglottis, or tri-form as in *Drep. venusta* and *D. anatina*; but it is a large monœcious epithelial sac, situated dorsally in the anterior distal third of the segment, and at its proximal end contracts itself into a tortuous efferent canal (Fig. 5 A, *a*—*b*). The spermatozoa are secreted in follicles, which are spread over the epithelial wall of the testicular sac. The spermatospores, which are budded off, are oval nucleated cells, and are aggregated together in colonies forming spermatospheres (Fig. 6). They do not increase their individuality by division of the whole cell, as in the spermatospore of the earth-worm; but the central nucleus splits up into minor (reticulated) cells, and the individual spermatozoon is evolved from these daughter cells. Thus a single spermatoblast produces a number of spermatozoa. When seen in the examining media, the spermatoblasts bear a striking resemblance to the floating fronds of *Lemna polyrhiza*. The spermatozoa from each spermatoblast form themselves into one common strand, and these strands coil or entwine round each other in the form of a "hempen warp." The tails of the spermatozoa are always free, and they are spread out like a number of loose threads (Fig. 7). In this

stage the spermatozoa are passed down through the vasa efferentia into the vesicula seminalis, to undergo their final development.

In its early stage the vesicula seminalis (Fig 5 A *c*), whose function is the reception and perfecting of the spermatozoa, is a straight tube or canal, a saccular prolongation of the vasa efferentia, in fact, with a small constriction in its centre. It is capable of distension, and is so distended as the spermatozoa accumulate. As development proceeds and it becomes filled with the sperm, the constriction doubles upon itself to form a loop, and thus divides it into two compartments—the distal and proximal sections. The distal portion is bulbous, and in it the spermatozoa are perfected; the proximal is pyriform, and elongates itself to form the vas-deferens "exterior" (Fig. 5 A *d*). This is dorsal to, and runs partially over, the receptaculum seminis; it then bends downwards, sinuously, medio-ventrally, and, previous to entering the cirrus-pouch, it swells out to form a heart-shaped gland, probably the prostate gland (Fig. 5 A *e*). That portion of the vas deferens which enters the cirrus-pouch, and for a short distance after it has done so, becomes a stout muscular conduit, the muscles forming themselves into rings. These rings have a diameter of 0·007 mm. At the proximal end of this pipe it again becomes a sinuous canal, the vas deferens "interior" (Fig. 5 A *l*). It attaches itself to the cirrus, and, previous to sexual maturity, appears as a sinuous attenuated sac, or elongated vesicle, within the pouch.

As the spermatozoa within the distal bulbous vesicula seminalis perfect themselves by the development of the head and the shedding of the spermatoblast, they loosen and disintegrate themselves, and in this condition are passed down the vas deferens "exterior," through the vas deferens "interior"; into the "sac" within the pouch (Figs. 5 A and 8 *k*). As the sperm accumulates within, the sac gradually expands, and continues to do so, until by its distension it impinges so closely against the walls of the pouch that it might pardonably be mistaken for the epithelium of that organ. When it is emptied by the act of coition,—there are times when it is only partially emptied, as during the act of coition the sperm secreted continues to flow in by the vas deferens—it again returns to its former state; and, when once emptied, or even partially so, it is never again refilled. I designate the distal vesicle the vesicula seminalis "superior," and that within

the pouch the vesicula seminalis "inferior"; because the latter is merely for the storage of the sperm previous to its reception, by the medium of the cirrus, into the receptaculum seminis; whereas the functions of the former are of a more important nature, viz., the development and perfecting of the spermatozoa.

It is not my intention at this stage to describe the growth and evolution of the genital tract, but merely to remark that in its early stage of development the male genital organ is a long sinuous tubular body, whose orifice is formed like the distal end of a speaking-trumpet, or the corolla of the Caprifoliaceæ (Fig. 9). This sinuous tube afterwards forms the vas-deferens inferior. In mature specimens the orifice is raised within the cloaca, or it is surrounded by a coating of ring muscles, and an outer layer of undulating longitudinal muscles, intermingled with cellular tissue. It assumes, by contractility, various forms, such as circular, quadrangular, and stellate or pentagonal; its normal diameter is 0·034 mm.

The cirrus-pouch (Fig. 5 A *f*) is a complex muscular structure; it is situated in the anterior dorsal proximal third of the proglottis, but it is ventral to the dorsal nerve. It is an elongated pyriform body, whose length is approximately 0·354 mm. and width through the median line 0·135 mm. It is composed of a structureless cuticle; a layer of broad oblique muscles having, individually, a diameter of 0·007 mm.; a middle layer of very fine thread-like closely compacted circular muscles; and lastly there is a layer of longitudinal muscles (Fig. 10). In oblique sections, likewise in transverse sections, through the proximal portion of the pouch, these longitudinal muscles are seen to be seventeen in number, having a diameter of 0·003 mm. These muscles are enclosed by the endothelial wall, which is an inversion of the ectoderm; it also forms the cirrus sheath, which attaches itself to the vas deferens at the base of the cirrus.

The cirrus (Figs. 5 A and 11 *h*) is a long cylindrical flexible organ; its deferent pore is strengthened by a band of circular muscles; its length is 0·05—0·07 mm., and diameter 0·013 mm. It is not spinous, as Dujardin states it to be, but is a perfectly smooth tube both exteriorly and interiorly; and, together with its sheath, is invaginated within the pouch. The cirrus-sheath (Figs. 5 A, 12 and 13 *i*), is interiorly thickly covered by minute spines; they are not "wrinkles of the cuticle," as, when the sheath

is everted and stained, they stand out prominently under a $\frac{1}{16}$ mm. objective. Again, if the sheath is teased away from the cirrus, the shreds still bear the spines; neither is there any caducity of these spines in the forming uterine segments; they only disappear, like the cirrus, by absorption. The sheath has a diameter of 0·03—0·05 mm. I have formed the conclusion that Dujardin mistook the spinous cirrus-sheath for the cirrus, and looked upon it as an integral part of that organ.

The excessive inflation of the vesicula seminalis inferior, or sac, with spermatozoa, causes great pressure to be brought to bear on the longitudinal muscles of the cirrus pouch. This pressure drags up the cirrus, and with it the sheath, causing them to extrude and the cirrus to enter the vagina, whilst the resistance of the circular and oblique muscles contracts the sac, expelling the spermatozoa through the tubular cirrus into the vaginal canal, and thus filling the receptaculum seminis. After this the cirrus and sheath return again within the pouch, but there are times when both are left extruded from the genital cloaca.

The measurements given above in connexion with the male genital organs do not coincide with those given by Dujardin. This is immaterial, for implicit confidence is not to be placed in the use of the micrometer. In this case the free use I have made of it has been unavoidable, but in all cases I have given the mean of the many specimens of my own preparations, which I have examined and described.

Female Organs.

If the description given by Dujardin of the male organs is "terse," that of the female organs is more so; and it is given with such a reservation as almost to amount to a doubt.

"Un deuxième orifice situé au-dessous, arrondi et formé également d'une membrane hérissée de petites épines; œufs."

This is all the description given by Dujardin of the female organs of this tape-worm.

The female organs consist of the vagina, with its canal; the vulva; a receptaculum seminis, and fertilising canal; a paired ovary, and oviducts; yelk and shell glands; a uterine canal, and uterus (Fig. 5 B).

The vagina (Fig. 5 B *m*), with its canal and vulva, lies posterior to the cirrus pouch, in the same plane with it, which is somewhat

abnormal, and is 0·007 mm. lower down in the genital cloaca than the male genital orifice. In its early stage the orifice is, like that of the male, "trumpet-shaped," with an overlapping rim externally. Internally it slopes and forms a connexion with the vaginal canal. During development of the vulva it becomes covered by the muscular structure of which that organ is composed, and transverse and longitudinal sections show us that the interior of the orifice and vaginal canal are both smooth and free from spines. The muscular coating of the orifice performs the office—by its contractility, which is much in excess of that of the male—of a "clasping organ."

The vulva (Figs. 5 B *n* and 14) is an ampulla-shaped organ. From its earliest stage of development it is distinct, histologically, from the cirrus-pouch. In ripe segments it is a dark muscular body, its composition consisting of longitudinal and circular muscles. Its cuticle is covered by a dense dark mass of spines arranged like quills on a porcupine's back. Its length is 0·03 mm., and diameter 0·017 mm., and viewed dorsally it has the appearance of being a *cul-de-sac*; this is caused by the abrupt course taken by the vaginal canal.

Within the orifice the vaginal canal (Fig. 5 B *o*) is raised as a papilla, 0·002 mm. It runs straight through the interior of the vulva, makes its exit from that organ on the ventral side, and runs ventrally along the dorsal cuticle of the cirrus-pouch; it then curves sinuously, and makes a junction with, and forms the neck and cuticle of, the receptaculum seminis. Its diameter at the neck is 0·01 mm.

The receptaculum seminis (Figs. 5 B *p*, 15, 16) is situated on the ventral side of the segment, the monœcious testicular sac overlaying the posterior third of it. It is an abnormally large pear-shaped convoluted sac, its cuticle being a distended continuation of the vaginal canal. At the neck, where the canal enters the sac, I have failed to find any trace of a valvular apparatus. It convolutes itself into three parts—the proximal, the median, and the distal. The proximal third, through its polar axis, has a diameter of 0·101 mm., and the other two a uniform diameter of 0·169 mm. Its whole length is 0·805 mm. The proximal third of the receptaculum lies in the dextral third, and the other two in the median third of the proglottis; the distal third is rounded at its base, and runs forward proximally.

Transverse sections show that this organ is embedded in an elongated cavity of the parenchymatous tissue of the segments. The efferent pore is situated in the centre of the distal section on the ventral side. The efferent duct is much swollen at its base; it runs obliquely, proximally, across the receptaculum, and then descends horizontally to form the fructifying canal (Figs. 5 B, 15 and 16 *q*), finally entering the shell-gland. In its descent the oviducts, one on either side, attach themselves to it.

The ovaries (Fig. 5 B r^1, r^2) are paired organs, and are situated ventrally, one being porose and the other aporose. They occupy about one-seventh of the whole length of the segment, and the dorsal and ventral nerves may be taken as the lateral boundaries of the zone of their development. Each ovary has its distinctive characteristics. The porose is somewhat oval, its length being 0·236 mm. and breadth 0·101 mm.; whilst the aporose is pyriform, its length from base to apex being 0·219 mm., and greatest breadth 0·135 mm. Each ovary is composed of a number of secretive glands, or lobes, whose ducts lead to one common funnel-shaped sinuous efferent duct. Each oviduct forms a junction with, and on either side of, the fructifying canal, into which the ova are poured. They are there impregnated, in their descent to the shell-gland, by the descending spermatozoa from the receptaculum.

The yelk-gland (Fig. 5 B *t*) is situated in the centre of the proglottis, on the ventral posterior margin, and is ventral to the distal lobe of the receptaculum, which from the dorsal side of the segment partially covers it. In its early stage of development it is a flattened, oval, disintegrated gland, but it becomes a dense, dark, granulous, reniform body, from the centre of which, in an upward direction, proceeds the yelk-duct to the shell-gland. The dark granules are nucleated yelk-cells, and as the gland wastes away by the using up of these plastic cells, it becomes sub-globose, and finally is totally obliterated. It is 0·125 mm. to 0·179 mm. long, and 0·067 mm. to 0·111 mm. wide.

The shell-gland (Fig. 5 B *s*) is partially covered, at its base, on the ventral side of the segment, by the yelk-gland. It consists of 7—8 aggregated club-shaped glands, each one filled with nucleated shell-gland cells, having a diameter of 0·004 to 0·006 mm. The asci are very irregular in their formation, varying in diameter at the distal end from 0·076 to 0·096 mm. Each of

the asci coalesces with its neighbours at the base; thus the whole is one homogeneous gland, from either side of which branches off the distal and proximal uterine canals.

The uterine canal (Fig. 5 B *u, v*) on leaving the shell-gland is single, but becomes duplex, developing both distally and proximally. Both of these canals run under the posterior margin of each ovary, until arriving at the proximal and distal end respectively. The distal end runs upwards to the centre of the proglottis, forming pouches in its course to the lateral margin. Whilst development is somewhat retarded in the proximal end, it is accelerated in the distal, where the pouches rapidly develop and become filled with ova, more especially at the lateral margins, where one large orbicular pouch occupies the whole of the space in the distal region. The testicular sac disappearing very early—in fact, it is the first organ to be absorbed—allows of more space, and facilitates development in the distal more than in the proximal end, where the receptaculum, with its superfluous spermatozoa, is the last organ to be absorbed, being only preceded by the strong muscular cirrus-pouch. The proximal uterine canal confines itself to the narrow space between the receptaculum and the posterior margin of the proglottis. The pouches are thus for a time retarded in their development, and circumscribed according to their environment; but when the cirrus-pouch and receptaculum are absorbed, and likewise during absorption, they fill up the void caused by that act. The proximal lateral pouch is likewise contracted (Fig. 19 *p u p*), and continues so in consequence of the genital cloaca remaining a cavity in the uterine segments. There are fifteen pouches, nine proximal and six distal, besides the lateral pouches. There is no uterine pore, consequently they are blind pouches.

The embryonic eggs and the hexacanth stage (Figs. 17, 18) of the Tænidæ and Bothriocephalidæ have been so lucidly explained by Leuckart, Moniez, Van Beneden, Blanchard, and Stiles, in their published works, that I refrain from passing any remarks respecting them in connection with this species.

Description of Plates.

Plate 18.

Fig. 1. Inverted rostellum.—*a*, orifice; *b*, retractor muscles; *c*, protractor muscles. × 260.

„ 2. Longitudinal muscles from strobila.—*a*, method of spindle-cell attachment. × 260.

„ 3. Lattice-work muscular structure. × 50.

„ 4. Group of chalk corpuscles. × 440.

„ 5. Male and female organs of generation. *A*, Male, *B*, Female, × 115.—*a*, monœcious testicle; *b*, efferent canal; *c*, vesicula seminalis superior; *d*, vas deferens exterior; *e*, prostate gland (?); *f*, cirrus-pouch; *g*, male genital sinus; *h*, cirrus; *i*, cirrus sheath; *k*, vesicula seminalis "inferior"; *l*, vas deferens interior; *m*, female genital opening and vagina; *n*, vulva; *o*, vaginal canal; *p*, receptaculum seminis; *q*, fructifying canal; r^1, aporose ovary and duct; r^2, porose ovary and duct; *s*, shell-gland; *t*, yelk-gland; *u*, aporose, *v*, porose uterine canals.

„ 6. An aggregation of spermatospores. × 1600.

„ 7. Spermatoblast with developing spermatozoa. × 440.

„ 8. Cirrus-pouch. × 260. Letters same as Fig. 5.

„ 9. Early formation of male and female genital sinus. × 260.

„ 10. Muscular structure of cirrus-pouch. × 115.

„ 11. Cirrus denuded of its sheath to show flexibility. × 260.

Plate 19.

„ 12. 13. Showing spinosity of cirrus-sheath. × 350.

„ 14. Vulva, showing exterior spines and smooth vaginal canal. × 700.

„ 15. Receptaculum seminis. × 155.

„ 16. Fertilising canal. × 350.

„ 17. Ovarian eggs, various stages. × 595.

„ 18. Uterine eggs—*c*, hexacanth stage. × 595.

„ 19. Oblique lateral transverse section of proglottis.—*h*, cirrus; *m*, female genital sinus:—L M^1, longitudinal muscles of pouch; L M^2, longitudinal muscles of segment; O M, oblique muscles of pouch in section; P U P., proximal uterine pouch. × 155.

„ 20. Undulatory nerve. × 70.

„ 21. Development of distal uterine pouches. × 155.

New or Rare British Fungi.

By Ernest S. Salmon, F.L.S.

(*Read May 18th*, 1900.)

Plate 20.

Microsphæra Bäumleri P. Magn. (Figs. 1—3).

M. Bäumleri P. Magn. Bericht. Deutsch. Botan. Gesell. xvii., 148, Taf. ix., ff. 17, 18 (1899).

M. marchica P. Magn. *l.c.* 149, Taf. ix., f. 19 (1899).

Exsicc. Rehm, Ascom. 249 (sub *Erysiphe Martii*).

Hypophyllous (very rarely amphigenous), mycelium subpersistent or evanescent; perithecia more or less densely gregarious in floccose patches covering the surface of the leaf, globose-depressed, becoming hemispherical, 80—150 μ in diameter, appendages 8—20, usually 8—14, 4—6 times the diameter of the perithecium, flaccid, penicillate when mature, smooth or slightly rough, colourless, hyaline and delicate above, becoming refractive towards the base, apex about three times dichotomously branched when mature, branching vague and lax, branches of the higher orders more or less irregularly placed, tips of the ultimate branches not recurved, asci 4—12, ovate to oblong, usually shortly stalked, $55—70 \times 30—38$ μ., spores 4—6 (8 recorded by Magnus), $20—22 \times 10—12$ μ.

Hab.—New Pitsligo, Scotland, on *Vicia sylvatica* (in Berkeley's Herbarium at Kew).

The record of *M. Bäumleri* as a British plant rests on the single specimen, above mentioned, in Berkeley's Herbarium at Kew. This specimen was named "*Erysiphe communis*" (*E. Polygoni*) by Berkeley, and to some forms of that species *M. Bäumleri* bears a close resemblance. The present plant, however, may always be recognised, when mature, by the definite apical branching of the appendages (see Figs. 1 and 2). In *E. Polygoni*, although the appendages often become much branched, the branching is vague and never strictly apical. *M. Bäumleri* is very closely related to *M. Astragali* (DC.) Trev.—a species found in Britain on *Astragalus Glycyphyllos*—and scarcely differs except in the more branched apex of the appendages.

The distribution of *M. Bäumleri* is as follows:—Germany, Austria-Hungary, Italy, and Russia. Its host-plants are *Vicia cassubica* and *V. sylvatica;* and search for the fungus on the latter plant should be made in England.

Humaria carneola (Saut.) Wint. (Figs. 4—7).

Peziza carneola Saut. Fl. Herzog. Salzb. vii. Theil, 7 (Mitth. Gesell. Salzb. Landeskund. xviii., Bd. II.)

Humaria carneola Wint. in Hedwig. xx., 130 (1881); Sacc. Syll. Fung. viii., 123 (1889); Rehm, in Rabenh. Krypt. Fl. Deutschl. I., Abth. III., 959 (1896).

Ascophore minute, $\frac{1}{2}$—2 mm. in diameter, orange-red, sessile or subsessile, fleshy, glabrous, more or less truncate above, margin of disc often wavy, excipulum pseudo-parenchymatous; asci cylindrical, about 150 μ long, 5 μ wide, narrowed at the base into a slender often curved pedicel, apex not becoming blue with iodine; spores 4, rarely 8, 1-seriate, hyaline, continuous, broadly elliptical with blunt ends, containing usually a large guttula,

$14—16 \times 9—10$ μ, epispore minutely rough; paraphyses slender, septate, enlarged at the apex (about 4 μ wide) and usually curved.

Hab.—Associated with *Tetraplodon mnioides* B. & S., on a mountain called Quinag, near Inchnadamph, Sutherland, Scotland (H. N. Dixon, W. E. Nicholson, and E. S. Salmon, July 1899).

Easily known by the tetrasporous asci with minutely rough spores. Although as a rule four spores only become mature, each ascus nearly always contains in addition four rudimentary spores (Fig. 5), and rarely asci may be observed in which eight spores attain full development (Fig. 6). *H. carneola*, therefore, illustrates very clearly the passage from the octosporous to the tetrasporous condition, and shows that in the present case the four spores are due not to fewer nuclear divisions in the young ascus, but to the non-development of half of the spores.

H. carneola is apparently a very rare species; the only other locality known at present is Salzburg, Austria-Hungary, where it was originally discovered by Sauter.

Sterigmatocystis nigra V. Tiegh. (Figs. 8—10).

Aspergillus niger V. Tiegh. Comptes Rendus, t. lxv., 1092 (1867); Ann. Sci. Nat. sér. v., t. viii., 240 (1867); *l.c.*, t. xi., pl. 7, f. 3 (1869); Raulin, Ann. Sci. Nat., sér. v., t. xi., 205 (1869); Gayon, Mém. Soc. Sci. Phys. Nat. Bord., sér. ii., t. 1, 451 (1876).

Eurotium nigrum De Bary, Beitr. Morph. Phys. Pilz. I., § III., 21 (1870).

Sterigmatocystis nigra V. Tiegh. in Bull. Soc. Bot. France, xxiv., 102 (1877); Bainier, *l.c.* xxvii. 30, pl. 1, f. 4 (1880); Sacc. Syll. Fung., iv., 75 (1886).

Forming effused, powdery, black patches, 1—3 cm. across; fertile hyphæ erect, $700—1000 \times 12—15$ μ, smoky olive; head globose, black, basidia about 40 μ long, densely packed and

radiating on all sides from a central portion; sterigmata usually four at the apex of each basidium, obclavate, 8—10 μ long; spores globose, blackish, very minutely verruculose, produced in short chains, 4 μ diameter; mycelium slender, creeping, hyaline.

Hab.—On stale bread, Kew, England (G. Massee).

The description above given was drawn up by Mr. Massee from examination of the living Kew specimens.

S. nigra, which has been recorded from France and Germany, is a species which is found on many different kinds of matrix. Van Tieghem found it to occur "in dilutis gallis, in solutis tannino, saccharo, acido citrico, acido tartrico, etc.; in pane humido, in urina acida, in foliis deciduis, etc." The same author states that the sterile mycelium of the present species acts as a kind of ferment in a tannin solution, converting it into gallic acid and glycose. It was also observed that the spores in the course of their development gave off a strong odour of Chinese ink. Van Tieghem has recorded the occurrence of sclerotia in *S. nigra*, and the subsequent formation, after a period of rest, of perithecia containing discoid ascospores like those of *Eurotium herbariorum*. Bainier states that occasionally five sterigmata are produced on some basidia.

The only species of *Sterigmatocystis* recorded by Massee (Brit. Fung. Fl., III., 298) is *S. dubia*, very distinct from the present species in its white tufts and colourless spores.

Arthroderma Curreyi Berk. (Figs. 11—13).

A. Curreyi Berk. Outl. Brit. Fung. 357 (1860).

Illosporium Curreyi (Berk.) Sacc. Syll. Fung., iv., 660 (1886); Massee, Brit. Fung. Fl., III., 469 (1893).

This fungus, which is known at present only from Britain, where it appears very rare or is frequently passed over, occurred in fair quantity on dead leaves under trees in the Queen's Cottage Wood, Kew, in April, 1900.

Currey founded the genus *Arthroderma* in 1854, in the "Quarterly Journal of Microscopical Science," II., p. 242, pl. ix., ff. 6–8. Saccardo, in the "Sylloge," has transferred the fungus on which the genus was founded to the genus *Illosporium*, but it is, I think, certain that the present species should not be placed in that genus. In *Illosporium* the sporodochium is subgelatinous and waxy, the conidia being held together by mucus,—in *Arthroderma* the whole structure is floccose, and there is also the presence of the curiously articulated hyphæ described below.

The following description was drawn up from the Kew specimens which agree perfectly with authentic examples of *A. Curreyi* :— Cæspitulis glomeratim ordinatis, floccosis, albidis, tactu vitellinis, e hyphis articulatis 5—6 μ latis flexuosis repetito et intricatim ramosis formatis, articulis cylindraceis utrinque inflatulis (ossiformibus), ramorum apicem versus brevioribus, omnibus deinde plus minus minute asperulis, conidiis numerosissimis, minutis, sessilibus, discoideis, 2—2·5 × 1 μ, lævibus.

Forming little globular balls (from $\frac{1}{2}$—$\frac{3}{4}$ mm. in diameter), which are frequently aggregated into a clinging floccose mass, The general habit and appearance much recall a species of *Arcyria*, and the intricately wound and much-branched hyphæ resemble superficially the capillitium found in that genus. The thigh-bone-shaped (ossiform) articulations of the hyphæ are somewhat similar to those found in *Nematogonium*.

Explanation of Plate 20.

Figs. 1—3. *Microsphæra Bäumleri* P. Magn. 1, a nearly mature perithecium, with appendages × 150 ; 2, apex of a mature appendage × 400 ; 3, ascus and ascospores × 400 ; all from specimens (now in Herb. Kew) sent by Prof. Magnus.

Figs. 4—7. *Humaria carneola* (Saut.) Wint. 4, ascophore, attached by its mycelium to the stem of *Tetraplodon mnioides* B. & S., × 68 ; 5, tetrasporous asci (with 4 rudimentary spores) and paraphyses, × 400 ; 6, octosporous ascus × 400 ; 7, ripe ascospores × 400 (all from the Scotch specimen, now in Herb. Kew).

FIGS. 8—10. *Sterigmatocystis nigra* V. Tiegh. 8, a fertile hypha × 52; 9, basidium with 4 sterigmata (after Bainier, Bull. Soc. Bot. France, xxvii., Pl. 1, f. 4); 10, two spores, × 1000 (Figs. 8 and 10 drawn from Rab. Fung. Eur. nr. 2136, in Herb. Kew).

FIGS. 11—13. *Arthroderma Curreyi* Berk. 11, part of a dead leaf, with fungus, nat. size; 12, portion of articulated and branched hypha × 400; ditto, with conidia × 670 (all from specimen, now in Herb. Kew).

Actinocyclus Ralfsii

By Edward M. Nelson, F.R.M.S.

(*Read June 15th*, 1900.)

This interesting diatom, especially when viewed under a low power, is so transcendentally beautiful that it will attract the attention of even those who, like Gallio, "care for none of these things." The charm in this diatom consists not only in its remarkable system of rays, from which it derives its name, but also in its exquisite colouring. When, however, this diatom is viewed in a critical manner with a wide-angled oil-immersion lens all its lovely colour vanishes and its beautiful rays become so inconspicuous as to be hardly noticeable; in spite of this, however, its interest to a scientist will be rather increased than diminished. It is not difficult to account for the loss of the rays, for when the diatom is examined under a low power the dots, or more accurately the minute perforations in the silex, are so closely approximated to one another that they appear to run together and form rays, but when this structure is examined under a higher power of greater aperture, these dots are so widely separated that they cease to give this appearance of lines or rays.

The reason for the loss of the colour is not quite so obvious, for colour may be produced in a variety of ways *e.g.* by polarisation, by the unequal refraction of light, by diffraction, by the varying thickness of transparent thin plates, and lastly by pigments. Now we know that exceedingly minute objects, such as bacteria and micrococci, when stained by pigments do not lose their colour when examined by high powers; but on the other hand objects such as diatoms, which owe their colour to the diffraction of light by their minute structure, change their colour from violet to red and finally lose it altogether as the power, or rather the aperture, of the objective is increased. It is an instructive experiment to examine with dark ground illumination and a low-power objective, say one inch or $\frac{2}{3}$ inch of aperture ·25 to ·3 N.A., a slide containing various species of *Pleurosigma* that have different degrees of fineness of structure: the coarser forms will appear ruddy, those a little finer greenish,

those still finer blue, and some finer still will appear violet or even indigo.

Now if the lens be changed for one whose aperture is ·4 N.A., those that were ruddy will be colourless, and the structure that gave rise to the colour will be resolved, those that were green will be ruddy, and those that were blue will have become green, and so on. If a lens of still greater aperture be employed, those that were originally green will become colourless and will be resolved, and the colours of the others will be lowered a step in the gamut. This law, which holds good with other diatoms, quite breaks down with an *Actinocyclus Ralfsii,* for if we examine one on a dark ground with a low power those parts which were brilliantly coloured blue with transmitted light now become a golden yellow. Again, all other diatoms lose their colour when the structure which gives rise to it by diffraction is resolved, but with the *A. Ralfsii* the colour remains although the structure is resolved; and lastly other diatoms when viewed by axial transmitted light appear white, while this is brilliantly coloured, provided that a lens of suitable aperture be employed to examine it. The colour in this diatom is visible with transmitted light provided that the aperture of the objective used does not greatly exceed ·45 N.A.; the power of the objective or eyepiece is of no consequence, the aperture of the lens is the sole determining factor in the case, as may be proved by manipulating an iris diaphragm at the back of the objective.

There is a slide in my cabinet which contains both an *Actinocyclus Ralfsii* and a *Hyalodiscus stelliger.* This last diatom has an ordinary sieve-like structure of about 35,000 per inch. Now, these two diatoms act in precisely contrary manners, for on a light field with ordinary transmitted light the *Actinocyclus* is brilliantly coloured while the *Hyalodiscus* is colourless; but on a dark ground the *Hyalodiscus* is coloured, and the *Actinocyclus* colourless. In short, the *Hyalodiscus* follows the rule of all other diatoms, *e.g.*, the *Pleurosigmæ*, *Naviculæ*, etc., and behaves precisely like them. In *Actinocyclus Ralfsii* the only part which follows this general diatomic rule is the narrow margin which, with transmitted light, is a golden yellow,* but on a dark ground exhibits a blue-green tint; this is a diffraction

* This colour may be somewhat erroneously described, as its golden tint may be caused by the contrast with the brilliant blue close to it.

colour, which like all diffraction colours turns white on resolution, or more strictly speaking shortly before resolution.

The tint of the diffraction colour of a diatom depends upon (α) the aperture of the objective used, and (β) the obliquity of the illumination. By this means we may therefore roughly determine the fineness of any diatomic structure by matching the tint with one whose fineness of structure has been measured, or with a test plate of ruled bands.

Of course it is necessary that the comparison be made with the same objective and under the same conditions of illumination. A suitable illumination for this purpose is daylight, and an achromatic condenser with a central opaque stop, just large enough to give a dark ground.

The question then is: what is the cause of the colour in *Actinocyclus Ralfsii?* Obviously it cannot be a diffraction colour arising from the ordinary primary structure forming the "rays," which give the diatom its name, because as we have seen above, when this structure is resolved the colour is still visible, and no colour arising from diffraction is visible when the diffractor itself is resolved. It cannot be due to pigment, for if it were it would remain visible when the aperture was increased beyond ·45 N.A. It cannot be caused by thin plates, because it would require reflected and not transmitted light to render it visible. Polarisation and refraction seem quite out of the question; and as there is no other theory at hand the answer must for the present be left undetermined.

It was pointed out in 1897 (*Journ. Q. M. C.*, Vol. 6, ser. 2, p. 431) that with an apochromatic $\frac{1}{8}$ of 1·4 N.A., used in connection with a wide-angled oil-immersion condenser giving a large aplanatic cone, a very delicate perforated veil could be seen covering the whole valve of an *Actinocyclus Ralfsii.* This very delicate structure has obviously nothing to do with the colour in question, because it would require a far greater aperture than ·45 N.A. to develop upon a dark ground any colour arising from the diffraction of so fine a grating; and this question is quite independent of that concerning the different kind of illumination required to develop the colour, a point of which we have as yet found no explanation. If a *Hyalodiscus subtilis* whose structure is about 70,000 per inch, or twice as fine as that of *Hyalodiscus stelliger*, be examined on a dark ground

with a lens of ·25 N.A. no colour will be perceived, while the *H. stelliger* under similar conditions will be brightly coloured; if the aperture be increased to ·5 or ·6 the *H. stelliger* will be resolved, while the colour of the *H. subtilis* will be an intense blue. Now the resolution of the *H. subtilis* may be accomplished with a dry lens of ·95 N.A., used critically, but as this lens reveals nothing of the extremely delicate structure we are considering on *Actinocyclus*, it stands to reason that the colour, observed in *Actinocyclus* with quite a low aperture and with transmitted light, cannot possibly be caused by this delicate structure. To repeat the argument :—

Hyalodiscus subtilis.

This diatom when viewed upon a dark ground, with a lens whose aperture is ·55 N.A., is coloured; the structure which gives rise to this colour can be resolved by a dry lens of ·95 N.A.

Actinocyclus Ralfsii.

This diatom when viewed by transmitted light, with a lens whose aperture is ·25 N.A., is coloured; this colour remains when the coarse structure on the diatom is resolved; a dry lens of ·95 N.A., however critically used, is quite unable to resolve the fine veil on this diatom. If this fine veil were the diffractor which caused the coloration of this diatom, it would require a lens with an aperture of at least ·55 N.A. to develop this colour.

Finally, all diffraction colours vanish with transmitted light, but the colour of *A. Ralfsii*, with the exception of that on its narrow margin, is only visible with transmitted light.

In this narrow margin the single process or nodule is situated; this I find has a very finely perforated cap, very similar to those of the Aulisci which have been previously described. The resolution of this detail is exceedingly troublesome, and perhaps it is one of the most difficult images the microscope, as at present constituted, is capable of dealing with.

Comparison of a typical diffraction coloured diatom with an *Actinocyclus Ralfsii*. Objective $\frac{3}{4}$; ·3 N.A.

	Hyalodiscus stelliger.	*Actinocyclus Ralfsii.*
Transmitted light . .	colourless .	. coloured.
Dark ground . . .	coloured .	. colourless.
Coarse structure resolved .	colourless .	. coloured.

A Contribution to the Life History of *Ixodes reduvius* (Linn.).

By R. T. Lewis, F.R.M.S.

(*Read June 15th*, 1900.)

Plate 21.

Readers of "Science Gossip" will remember that during 1899 * a series of papers appeared from the pen of Mr. E. G. Wheler, of Alnwick, a member of this Club, entitled "Ticks and Louping Ill," in which the writer described the serious damage done by a disease amongst sheep, locally known under this name. Mr. Wheler subsequently communicated to the Royal Agricultural Society a more extended account of the observations made; this was published in the Journal of that Society, vol. x., part iv., 1899, and has since been reprinted for private circulation.

The species of tick held responsible for conveying the infection to the sheep, has been satisfactorily identified as *Ixodes reduvius* (Linn.). The determination of species in the case of ticks is, however, not so easy a matter as may at first be supposed, since individuals of the same species, especially the females, are found to vary in a remarkable degree as to size and colour, according to their age or condition as regards feeding, or repletion with ova, whilst the males often differ from the females in a still more marked degree. It is not therefore surprising to find on reference to Neumann's recent work, "Revision de la Famille des Ixodides,"† that his description of *Ixodes reduvius* is headed with a list of nineteen synonyms, under which this same creature appears to have been known to different writers.

Mr. Wheler's chief object in taking up the subject was to ascertain by what means the disease referred to might be successfully combated. As it appeared certain that these ticks were active agents in communicating the disease to the sheep, his first endeavour was to make himself acquainted as far as possible with their life history, and the exceptional opportunities which he enjoys for obtaining living specimens and studying them in their native habitat have been taken advantage of with excellent results. It is not intended in this paper to give any special description either of the ticks or of the mischief they are charged with doing—this

* Vol. v. pp. 5, 46, 108. † Part 3, p. 112.

having already been well done in the articles alluded to—but rather to call attention to an observation which Mr. Wheler was fortunate in making, and which adds a very important and interesting item to our somewhat imperfect knowledge of the ways of the ticks.

In the early autumn of last year Mr. Wheler mentioned in the course of correspondence with me that, from observations made, he had come to the conclusion that the impregnation of the female tick was accomplished by means of the rostrum of the male, and not by a special intromittant organ as in the case of insects, and that for this purpose the rostrum was entirely inserted into the generative orifice of the female. In proof of this somewhat surprising statement photographs as well as mounted specimens of ticks *in copula* were submitted, which clearly showed connection between the individuals in the manner described. On looking up such authorities as were to hand, and also on mentioning the matter to correspondents in the colonies who are making a special study of these creatures, I found that though all assumed the fertilisation to be performed in the usual way, by contact between the genital organs of the sexes, no one had actually seen the process, although several who had noticed that the males ran under the females said that they attached themselves to the host in that situation; one writer, going a little further, affirming that the male attached himself to the host beneath the female in an inverted position, although this feat would obviously involve a movement of the rostrum in a direction precisely opposite to that provided for by the structure of its articulation. So many peculiarities were however already recognised in connection with the reproductive processes amongst the Arachnida that I felt not only much interested, but quite prepared for an acquaintance with yet another surprise.

Wishing me to see the procedure for myself and thus be able independently to confirm his observations, Mr. Wheler sent me a few living ticks in their early mature stage, males and females being in separate tubes; and instead of quoting his own description, I purpose, with his concurrence, simply to describe what I myself witnessed.

A male and female tick having been selected, were placed in a reversible glass cell large enough to allow them ample freedom of movement, the cell being placed on the stage of a binocular microscope under a 2-in. objective and viewed in the large field of

a pair of Kellner eyepieces. After a preliminary examination of their new quarters the female took up a position on the cover glass, the male meanwhile restlessly wandering about the cell and occasionally walking over the stationary female. In the course of half an hour he restricted his excursions to the immediate neighbourhood of the female, subsequently crawling upon her dorsal surface, which underwent a careful examination for several minutes. After several attempts he next succeeded in passing over the posterior margin of the abdomen to the ventral surface, and obtaining a firm hold with all his feet established himself in such a position that the extremity of his rostrum was exactly in contact with the closed orifice of the female organ, which in this species is situated between the basal joints of the fourth pair of legs. The palpi of the male were up to this time closely enfolding the rostrum in the usual position occupied by them when at rest. The next ten minutes were occupied in slowly passing the rostrum and palpi to and fro across the closed orifice, until at length the female, which had remained hitherto entirely passive, began to show signs of responding: a slight, but very distinct alteration in the colour of the surrounding parts took place, this being shortly followed by a relaxation of the peculiar crescent-shaped, flap-like opening. The palpi of the male were now immediately separated as widely as possible, the extremity of the rostrum was inserted under the flap and gradually pushed home until the entire organ was buried to its base. No further change in the situation took place for some hours, but on the following morning I found that the ticks had separated; they were then removed from the cell for future examination. On three other occasions I repeated the experiment, each time with the same ultimate result, the procedure being precisely the same in every instance except as to time occupied; but as the winter came on, the ticks became more torpid, and finally refused to take any notice of one another, although several of them remained alive until April of the present year.

Neumann, in common with most writers, describes the male genital orifice in *I. reduvius* as being wide and situated between the basal joints of the third pair of legs. There is undoubtedly what appears to be a tightly closed transverse orifice of considerable width in the position mentioned, but if this really represents the male organ it is clear that when locked in the position described it is impossible for the organs of the two sexes to be

even approximately in apposition. Neumann also calls attention to the dissimilarity observed between the rostrum of the male and that of the female as being a character of this species.

The question, however, naturally suggested itself that if what I had seen was really an act of fertilisation, a careful examination of the rostrum of the male might reveal something which had hitherto escaped notice. I was encouraged in this idea by the remembrance of my observation on the deposition of eggs by a tick in 1892,* in the course of which I discovered the existence of a new and hitherto unsuspected organ which appeared and came into operation at that particular time, an observation which exploded the old notion that the eggs were laid through the mouth, and revealed one of the most complicated and remarkably fascinating processes yet seen in connection with the phenomena of oviposition. The description given of it was at the time regarded in some quarters rather as a romance, but it has since been confirmed by so many independent observers as to admit of no further incredulity. In the case of *I. reduvius* it was described and figured by Mr. Wheler in *Science Gossip* for 1899, p. 109.

Most microscopists are familiar with the mouth organs of ticks as mounted objects, but those who have only seen them as such have still much to learn as to their remarkable structure,—to be properly understood they must be studied in the living state. Although the general features have been often described, it will perhaps not be time wasted to once more call attention to them. In both sexes the rostrum, as seen in profile (Figs. 3 and 5), is divided into two parts, of which the lower, known as the labium or hypostome, is armed on its under side with reflexed spines or teeth, whilst the upper portion appears to be tubular and (at least in the case of the female) to contain the shafts of three pairs of cutting instruments—the mandibles or apophyses—the serrated blades of which extend beyond the terminal extremity of the tube. From the dorsal aspect, the two sheaths or tubes are seen to be of oval shape, their inner edges lying in close contact and their under surfaces resting upon the upper, smooth, but slightly concave, face of the labium. Their length, when fully extended, is nearly the same as that of the labium, beyond which the mandibles then project. The shape and position of the blades of the mandibles are as drawn, the inner pair being grooved as shown in the figure of those of *Ixodes Varani* in the Q.M.C.

* *Journal R.M.S.*, 1892, pp. 449-54, plate vii.

JOURNAL for 1892, (vol. v., plate 1,) and both the inner and outer mandibles of each pair are jointed upon their respective shafts, so as to allow of a movement through an arc of about 90° from the median line. In mounted specimens these sheaths appear to be rigid structures. In dried specimens they are thin, hard, and brittle, but in the living tick they are seen to be pliable, elastic and capable of free and independent retraction; the shafts of the mandibles being withdrawn within the body of the tick, the blades remain exposed as before, but the sheaths themselves shorten until they disappear by a process of invagination after the manner in which a snail draws in its tentacles. The labium, as seen from its ventral aspect, presents distinctly different features in the two sexes. In the female (Fig. 2) its margin is armed on either side with a row of extremely hard, sharp, arrow-pointed teeth, eleven or twelve in number, increasing in size and strength from the extremity to about half-way down, thence diminishing again towards the base. The convex under surface of the labium is also set with reflexed teeth, three rows on either side of the median line—those near the tip being small and crowded together—but increasing in size in about the same ratio as the marginal rows, and becoming sparse and disappearing about the same distance from the base. In the case of the male (Fig. 4) the labium is shorter; the marginal teeth are five or six in number and abruptly end with the largest of the series at rather less than half the distance between the anterior extremity and the base, the teeth upon the ventral surface being few in number and projecting so slightly as to be little more than crenulations. A little below the position of the last of the marginal teeth there are, however, what appear in a dry specimen to be two reflexed teeth, one on either side of the median line, these being of larger size, thicker at the base and longer but not so sharp, and differing also in apparent structure from any others of their kind. On forcibly separating a male from a female and examining the rostrum of the former immediately after its withdrawal from the vulva, I saw at once that these supposed teeth had increased in size and now presented the appearance of flexible semi-transparent tubular papillæ, which conveyed the impression to my mind that here, possibly, were the organs by means of which the actual impregnation took place. I killed this tick without loss of time, and removing the entire capitulum before it had time to dry or contract, mounted it forthwith in glycerine. As thus mounted,

with no preparation and no pressure other than that of the cover-glass, these papillæ can still be seen in their distended condition under a $\frac{1}{2}$-in. objective, as in Figs. 4 and 5. As the summer season approaches and ticks become more abundant it is hoped to complete these observations by determining whether during this connection spermatophores actually pass. Until then it may perhaps be unwise to assume that what has been seen is the actual method of impregnation in *Ixodes reduvius*, although it will probably be conceded that there is a strong *primâ-facie* case; nor is it taken for granted that the process is common to other genera. Correspondence with some of the most careful investigators of tick life-history in our colonies failed for a long time to elicit evidence of other than a negative character—no one had seen anything of the kind take place, and what had been observed here was regarded as something abnormal. However, in December last Mr. Wheler received a letter from Mr. Chas. P. Lounsbury, the Cape Government entomologist, in which he mentioned having recently met with a species of tick previously unknown to him, but recognised since as *I. pilosus* (Koch), which appeared to resemble *I. reduvius*, scores of which he found in apparent copulation with the females in exactly the manner described. In January last Mr. Lounsbury was good enough to send me some specimens of these ticks, *in situ*, preserved in formalin. The females are apparently fully inflated, so that the disparity in size between males and females is great; but it can be seen at once that in every case the males are attached to the females, holding on to the ventral surface with all their feet and having the rostrum buried to its base in the female orifice.

Although perhaps not at the moment absolutely conclusive, the observations have been thought sufficiently interesting and important to bring before the members of the Club.

Explanation of Plate 21.

Fig. 1.	*Ixodes reduvius*,	♂ and ♀ in copula, as described and exhibited alive at the meeting	× 18
Fig. 2.	„ „	Hypostome of ♀, ventral aspect	× 70
Fig. 3.	„ „	Rostrum of ♀, lateral aspect ...	× 70
Fig. 4.	„ „	Hypostome of ♂, ventral aspect, showing two genital processes fully dilated	× 70
Fig. 5.	„ „	Rostrum of ♂, lateral aspect, showing processes fully dilated ...	× 70

On a Form of Structural Division of the Endoplasm observed in the Bacilli of the Bubonic Plague and other Microbes.

By A. A. Merlin, F.R.M.S.

(*Read June 15th*, 1900.)

Probably there are no objects on which in recent years so much labour has been expended, and which have been so persistently and diligently scrutinised under the highest powers of the microscope, as the Bacteria. Under such circumstances as these it may seem rash to suppose that any of the well-known forms should possess resolvable structural features hitherto overlooked and unrecorded. As, however, the microbe cell is usually described as typifying the simplest existing cell structure, in which only a kind of granulation has been occasionally seen, it may prove of interest to draw your attention to the fact that certain exceedingly minute internal structural details have been recently observed within the stained forms of the bubonic plague and some other bacilli, pointing to the existence of a regular subdivision, or partition, of their cell contents.

In the accompanying figures I have endeavoured to delineate the points referred to, which may be observed in any well-stained balsam preparations of the specified forms, only requiring good optical means and careful manipulation to render them visible.

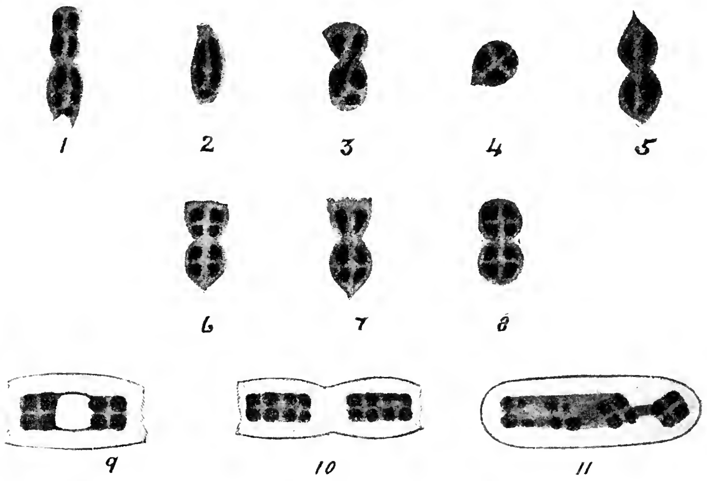
Figures 1 to 7, inclusive, are sketched from cultivated and strongly blue-stained specimens of the plague bacillus, which species has been found on the whole to show the structure in question more plainly than any yet examined.

Fig. 1 is of a double form, measuring in its entirety about the $\frac{1}{7000}$th of an inch in longitudinal diameter. The upper component cell has a distinct central constriction, its darkly stained endoplasm being separated, and divided into four equal portions, by a cross partition apparently composed of the same substance as that of the investing envelope; in other words the cell contents appear to be symmetrically embedded in, and separated by, the homogeneous gelatinous material of which the remainder of the cell is composed. The lower cell has no central constriction, its contents being arranged as figured. In this, and most other

double forms, the longitudinal fissure in the endoplasm is more distinctly definable than the lateral.

Fig. 2 is of a single form, in the same field as the preceding, about the $\frac{1}{14000}$th of an inch long. In size and arrangement of its contents it is an exact facsimile of the lower component of Fig. 1. The marked similitude of the internal features in these two specimens seems to clearly lead to the conclusion that the existing arrangement can be due to no fortuitous circumstance, but represents a definite stage in the evolution of the cell.

Fig. 3 shows a double form, the whole measuring longitudinally about the $\frac{1}{14000}$th of an inch. The upper component exhibits a



very commonly existing variation in shape from its companion cell. A longitudinal fissure is alone visible in the upper cell, the lower having a tripartite arrangement of the contents. In this specimen the endoplasm of the upper is united to that of the lower cell, as shown in the figure—a somewhat rare feature.

Figs. 5, 6, and 7 are drawn from other examples of the plague bacillus, showing variation in form and arrangement of cell contents. In some of these the points of attachment of the flagella can be well seen, distinctly flagellated specimens being frequently observable.

Fig. 4 is a single plague coccus, about the $\frac{1}{30000}$th of an inch in diameter, exhibiting a well-marked cross partition of its

endoplasm. The protuberant knob or boss is a common feature in many such micrococci, and when present appears to be invariably situated on the line of one of the internal divisional partitions; the flagellum also, when observable, having its point of attachment so placed. The protuberances may therefore be partly due to the contracted or coiled-up flagella.

Almost all micrococci of the plague and other species examined, such as those of pneumonia, swine fever, gonococci, etc., exhibit the characteristic quadripartition of their contents; but as many individual examples are considerably under the $\frac{1}{40000}$th of an inch in diameter, the details of their internal structure are in such instances beyond the range of our present optical means, although traces of the divisional partitions may be detected in smaller forms than might be expected.

Fig. 8 represents a double gonococcus, about the $\frac{1}{16000}$th of an inch in longitudinal diameter, showing a quadripartite arrangement of both cell contents.

It is believed that most of the bacteria with figure-of-8 or micrococcus forms will be found to possess a structural disposition of their endoplasm analogous to some one of the above examples. Micrococci in zooglœa exhibit a similar appearance to that shown in fig. 4.

Of the rod-like and filamentous varieties the *B. anthracis* will prove interesting. Fig. 9 represents a segment from a long filament of this microbe in process of spore formation. The endoplasm is here arranged in a tetragonal form on either side of the translucent and highly refractive spore, each tetragon having its contents divided into four equal parts as figured. The spore is in this instance not fully grown, mature spores being usually more elongated. Very large spores occupy much of the available space in the segments, thus crowding and greatly compressing the adjacent endoplasm.

Fig. 10 shows the structure of two sporeless segments from another filament on the same slide. The partitioned squares of endoplasm are in this case arranged in pairs. From the study of other specimens it would seem that the spore is found between such contiguous squares, gradually pushing them apart in the progress of its growth until each segment resembles Fig. 9.

Fig. 11 is of a long segment, the contents of which are somewhat curiously disordered. An irregular disposition of the

endoplasm of this nature is very commonly existent in the longer segments.

Although the figures are drawn on a larger scale, a power of about 2300 diameters was found advantageous, and was generally adhered to in these observations, this magnification being obtained by means of an apochromatic $\frac{1}{8}$th of N.A 1·4 used in conjunction with a 27 ocular. A solid axial cone of about 1·2 N.A. from an oil-immersion condenser was found to yield the best results; but the full aperture of Powell's dry apochromatic condenser also proved satisfactory, exact adjustment for thickness of slip being in the latter case effected by the correction collar.

Strictly critical illumination is of course a *sine qua non* when dealing with such minute structure, and Gifford's blue-green glass and glycerine methyl-green screen should be employed. Under these conditions I have seen most of the points alluded to with a good objective of N.A. 1·3, but poor lenses are not likely to prove adequate.

In this and other delicate work under the highest powers, so far as my experience extends, it would appear to be almost as necessary that the substage condenser should be in as exact adjustment as the objective itself. With regard to this matter, it would doubtless prove a boon to many workers were the thickness of slip for preparations requiring any considerable magnifying power to be standardised, so that the many excellent dry condensers of large aplanatic aperture now obtainable in fixed mounts could be relied upon to work well on the majority of mounted slides, which is far from being the case at present. Well corrected oil-immersion condensers are practically exempt from this drawback, as they perform satisfactorily through slips of very varying thickness; but their constant employment, when a cone exceeding N.A. 1·0 is not required, involves much useless trouble and loss of time.

I trust that I shall be pardoned by careful workers for having thus dwelt on matters that are familiar to them, but in so doing I have sought to emphasise the fact that the rough-and-ready manipulation of an instrument furnished with an unsuitable condenser cannot be expected to reveal the structural details referred to in this note.

A List of Fresh-water Mites found near Oban, N.B.

By Chas. D. Soar, F.R.M.S.

(*Taken as read June* 15*th*, 1900.)

Mr. Taverner, a member of this Club, has kindly sent me two distinct collections of fresh-water mites from the district round Oban, N.B. On examination, I found the collections to comprise about two thousand specimens in all, representing about forty species belonging to some twenty genera.

I cannot discover that we have had a list of Scottish Hydrachnidæ published before, so I think this will be a good opportunity to put such a list on record. It will, I hope, serve as a foundation which can be added to from time to time, as other species are found by future collectors. The collections now under consideration were made in June and July 1898, and in July 1899. The last-named year yielded the greatest number of species. This was probably owing to the collections in that year having been made over a larger area than in 1898.

It may be interesting to note that there is one mite which is a very common one in England that does not appear in this Scottish list, and that is *Arrenurus globator*, Müller. In England I have taken more specimens of this mite than any other except *Diplodontus despiciens*. It figures in quite eight collections out of every ten, and being so common here, it is very remarkable that Mr. Taverner failed to find it in Scotland. But against this absence of a very common species we have to set three others not before recorded in Britain. These are *Acercus ligulifer*, *Oxus longisetus*, and *Torrenticolor anomala*, all very rare, only one specimen being taken of each. Figures and descriptions of all these can be found in Piersig's great work on German Hydrachnidæ (Deutschlands Hydrachniden, "Zoologica," Heft 22, 1897—1900).

There is one other point to which attention may be directed,

and that is in connection with the naming of the single species of *Eylais* here recorded. The species of this genus are very difficult to identify, the great point of recognition according to Piersig's key being the form of the eye-plates. Now, I find these eye-plates to vary more or less in every specimen I have examined, and I am at present in correspondence with Dr. Piersig on the subject. I do not think there is any doubt, however, that the species found by Mr. Taverner (No. 38 in the list) is any other than *Eylais soari*, Piersig.

HYDRACHNIDÆ.

Sub-family: Hygrobatinæ.

Genus i. **Atax.**

1. Atax crassipes. Müller. Common.

Genus ii. **Curvipes.**

2. Curvipes longipalpis. Krendowsky.
3. „ carneus. Koch.
4. „ nodatus. Müller.
5. „ fuscatus. Hermann.
6. „ rufus. Koch.
7. „ conglobatus. Koch.
8. „ circularis? Piersig. Only one specimen, a female, not quite typical.
9. „ obturbans. Piersig.

Genus iii. **Acercus.**

10. Acercus ligulifer. Piersig. This is the first time this species has been found in Britain.

Genus iv. **Wettina.**

11. Wettina macroplica. Piersig.

Genus v. **Atractides.**

12. Atractides spinipes. Koch. Only two specimens taken.

Genus vi. **Hygrobates.**

13. Hygrobates longipalpis. Hermann.
14. „ reticulatus. Kramer.
15. „ nigro-maculatus. Lebert.

Genus vii. **Limnesia.**

16. Limnesia histrionica. Hermann.
17. ,, koenikei. Piersig.
18. ,, maculator. Müller.

Genus viii. **Sperchon.**

19. Sperchon setiger. Thor.

Genus ix. **Lebertia.**

20. Lebertia tau-insignita. Lebert.

Genus x. **Oxus.**

21. Oxus strigatus. Müller.
22. ,, longisetus. Berlese. New to Britain.

Genus xi. **Frontipoda.**

23. Frontipoda musculus. Müller.

Genus xii. **Brachypoda.**

24. Brachypoda versicolor. Müller.

Genus xiii. **Aturus.**

25. Aturus scaber. Kramer.

Genus xiv. **Torrenticola.**

26. Torrenticolor anomala. Piersig. One specimen of female only. First record in Britain.

Genus xv. **Mideopsis.**

27. Mideopsis orbicularis. Müller.

Genus xvi. **Arrenurus.**

28. Arrenurus maculator. Müller.
29. ,, albator. Müller.
30. ,, securiformis. Piersig.
31. ,, cuspidifer. Piersig.
32. ,, forpicatus. Neumann. The common colour of this mite is brick-red, but some in this collection were a vivid green.
33. Arrenurus zachariæ. Koenike.
34. ,, crassicaudatus. Kramer.

SUB-FAMILY: HYDRYPHANTINÆ.

GENUS XVII. **Diplodontus.**

35. Diplodontus despiciens. Müller.

GENUS XVIII. **Hydryphantes.**

36. Hydryphantes ruber. De Geer.
37. ,, dispar. Von Schaub.

SUB-FAMILY: EYLAÏNÆ.

GENUS XIX. **Eylais.**

38. Eylais soari. Piersig. Several specimens of this Hydrachnid were found, and also a very closely allied form that I have not been able to name, but which may very probably be the same species undeveloped.

SUB-FAMILY: HYDRACHNINÆ.

GENUS XX. **Hydrachna.**

39. Hydrachna globosa. De Geer.
40. ,, scutata. Piersig.

The Swimming Peculiarities of *Daphnia* and its Allies, with an account of a new method of examining living Entomostraca and similar organisms.

By D. J. Scourfield, F.R.M.S.

(*Read October 19th*, 1900.)

The genus *Daphnia*, as understood by Baird and other of the older writers on Entomostraca, has for some considerable time been recognised as embracing four types of animals to which the names *Daphnia*, *Ceriodaphnia*, *Simocephalus*, and *Scapholeberis* have been given. The separation of the old genus into these four new genera, although at first, perhaps, hardly based on sufficient evidence, has been abundantly justified, for the more we study these animals the greater becomes the number of the features characteristic of each type. But I do not wish to enter now into all the differences existing between *Daphnia* and its closest allies. I simply wish to point out that in addition to the morphological distinctions there is also a fundamental difference in the swimming habits of *Daphnia* and *Ceriodaphnia* on the one hand and *Simocephalus* and *Scapholeberis* on the other, for whereas the two former always swim either vertically, or obliquely back uppermost, the two latter always swim more or less obliquely back downwards. These peculiarities in the method of progression in the water are so constant that, if the animals are seen swimming, it is absolutely impossible to mistake say a *Daphnia* for a *Simocephalus*, even with the naked eye.

From the moment when I first recognised this important distinction between the two pairs of genera mentioned, I have

had a strong desire to find out the reason why the facts should be as they are. As I have now, I believe, made some progress towards a solution of the problem, it may prove interesting if I place before you what seems to be the explanation of the phenomena in question. In doing so I will follow the steps by which I have been led to my present conclusions, as some of the details of investigation may prove useful to other workers.

As I did not think it possible that there could be any great difference in the relative positions of the centres of gravity in animals so closely similar to one another, my first theory to account for the difference in the mode of swimming was that it was due to the direction of the stroke of the large antennæ. I thought that the normal direction of the stroke in *Daphnia* and *Ceriodaphnia* would be found to be nearly parallel to the long axis of the body, or, if oblique to this line, then inclined slightly towards the back, whereas in *Simocephalus* and *Scapholeberis* the stroke would be found to be decidedly oblique to the long axis but directed towards the ventral margin. The idea underlying these suppositions was, of course, that the long axis of the body in each case would tend to arrange itself in the line of motion, or in other words parallel to the direction of the stroke.

To ascertain whether this theory was correct or not, I devised a method of suspending the animals by the top of their heads in such a way that they could use their antennæ and all other organs with perfect freedom, and yet not alter their position in the water. This was done by attaching the little creatures by means of a minute drop of some micro-cement to the end of a pin which had been run through a piece of cork made to fit on the top of a small glass tank or trough. (See Fig. 1. The size of the animal is somewhat exaggerated in order to show the method of attachment more clearly). As this method of examining living Entomostraca, and also, of course, many other aquatic organisms, seems to offer many possibilities for investigating questions which have not hitherto been within the range of the biologist's "practical politics," I may as well give here such details as will enable any one interested to make similar experiments for himself.

The first thing is to cut a piece of cork so that the lower half fits between the two plates of a glass trough or similar

vessel, while the other half rests on their upper edges. Through this piece of cork a fairly long and stout pin is driven and worked about until it moves without requiring much effort. The point of the pin is next filed down until it is a thin wire of not much more than about $\frac{1}{100}''$ in diameter, and the tip is then bent round, at right angles to the main shaft, into a tiny loop which is intended to retain the drop of cementing material. It is necessary to have a loop,* as the cement will be found to retreat up the pin if a sharp point only be used.

Presuming that the glass trough filled with water is in readiness, and that the cement is close at hand, the next thing to

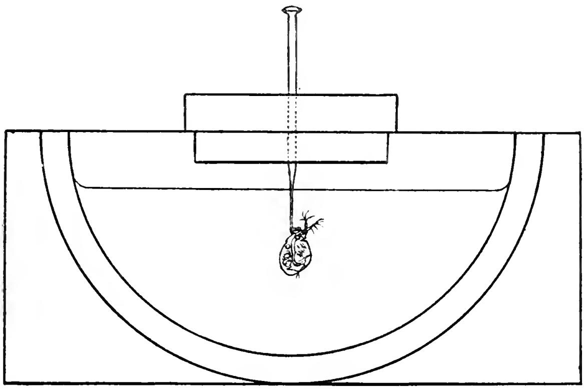


Fig. 1.

be done is to place the animal to be examined on a glass slip, and, with a piece of blotting paper, to remove as much as possible of the moisture clinging to it. Without loss of time the loop at the end of the pin must now be dipped into the cement and gently applied to the head or other part of the animal, according to the particular investigation one has in view. In a few seconds the cement, if suitable for the purpose, will have sufficiently hardened to allow of the animal, suspended from the end of the pin, being placed in the water in the trough, and its position adjusted for examination. If the various processes

* A truncated tip will do in some cases, but it does not seem so satisfactory as the minute loop.

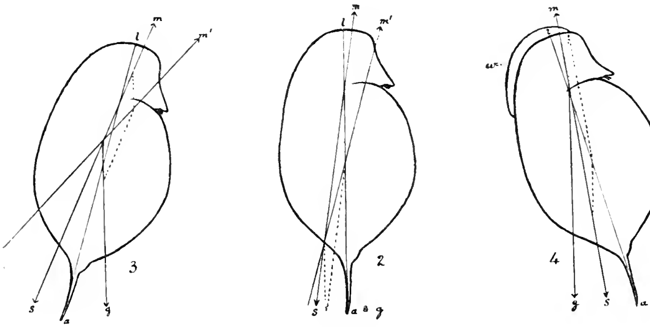
have been carried out carefully, the animal will not be found to have been in any way injured by the treatment, and will soon commence to swim for dear life—so it thinks, no doubt, but if the cement is good, it does not budge a μ. Unfortunately the great trouble with the method has been to find a really reliable cement. It is evident that a cement for this purpose must be very tenacions even in most minute quantities, that it must set rapidly, that it must not be soluble in water, but, on the contrary, must even set under water, and, most important of all, that it must have no bad effects upon the animals. I must frankly admit that, after trying most of the ordinary micro-cements, I have not yet found one thoroughly satisfactory, but I have obtained the best results with sealing-wax dissolved in alcohol. This cement will hold many Cladocera quite well for periods varying from a few minutes to half an hour or more, but it will not hold Copepods longer than a few seconds to a minute or so. I shall be very pleased to have any suggestions as to a good cement for the purpose in view.

To return to the question of the swimming habits of *Daphnia*, etc. As stated above, the point to be settled was whether *Simocephalus* and *Scapholeberis* really did swim upon their backs because they beat their large antennæ towards their ventral margins. By experimenting with *Simocephalus vetulus*, on the lines just explained, I soon found that my theory was untenable, for it was easily observed that the current of water produced by the normal movement of the antennæ was not only not towards the ventral margin, but was actually somewhat inclined towards the back. (See Figs. 5, 6, and 7, in which the line *ms* represents the direction of the stroke. The opposite direction *sm* necessarily represents the resulting line of movement.) The direction of the current produced by all the specimens examined—and the same fact was afterwards observed in the case of *Daphnia*—was as nearly as possible identical. No current in any other direction was ever observed. I should be sorry to deny the possibility of these animals using their antennæ in other ways, but there seems no doubt that each species has a practically constant direction of stroke under ordinary circumstances.

I next examined species of *Daphnia* in the same way, and found that the direction of the stroke was practically identical with that of *Simocephalus*—*i.e.*, that it was inclined obliquely backwards

compared with the long axis of the body. (See Figs. 2, 3, and 4.) This direction was indeed what I had anticipated from the position of the animals of this genus when swimming, but it left me in the dark as to the reason for the difference in the mode of progression between *Daphnia* and *Simocephalus.*

The next step forward was due to two lucky accidents. In one case, during an unsuccessful attempt to fix a *Daphnia* by its head to a pin, in the manner already described, some of the sealing-wax cement was left attached to the animal, about as indicated by *w*



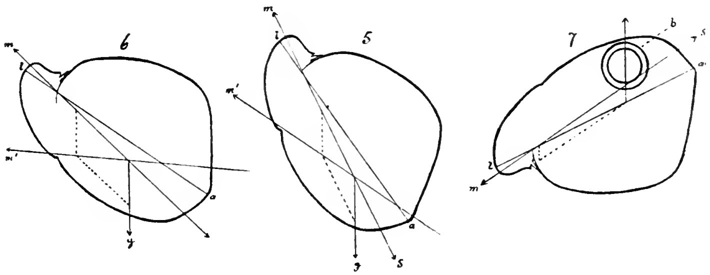
Figs. 2, 3, and 4.

la Long axis of body.
g Direction of action of gravity.
ms Direction of current produced by stroke of large antennæ.
*m*¹ Direction of the forward movement of the animal.
w Sealing wax (Fig. 4).
The dotted lines have been inserted to complete the parallelograms of forces.

in Fig. 4. When the animal was allowed to go free in the water again, it was observed that it now had a tendency to swim somewhat obliquely back downwards, as shown in Fig. 6. In fact, it was imitating the normal method of progression of a *Simocephalus.* The other observation was made with a *Simocephalus.* In this instance an air bubble (see Fig. 7, *b*) had got into the brood-cavity in consequence of the animal having been allowed to remain too long upon a glass slip without water. The creature was now somewhat lighter than water, and its swimming was most curious. It struggled hard against the upward pull of the air bubble, and

by the vigorous use of its antennæ it managed to make some progress in an obliquely downward direction; but it was no longer swimming in the manner of a *Simocephalus*, but as shown in Fig. 7, with its back upwards. It also clung to the sides of the glass in an inverted position, which is just the opposite to the normal behaviour of animals of this genus.

The two cases of abnormal swimming just alluded to, taken in connection with what had been already found out about the direction of the stroke, proved conclusively that the main factor in determining the positions of the animals when swimming freely must be the situation of the centre of gravity. Now, although it has not yet been found possible to discover the exact position of



Figs. 5, 6, and 7.

The letters have the same significance as in Figs. 2, 3, and 4.
b Air-bubble (Fig. 7).

the centre of gravity in any case, it is possible to find out the net result of the action of gravity. This can be done by watching how the animals sink when they stop using their large antennæ. This sounds simple, but in practice it is not so very easy, as Water-fleas are not in the habit of resting on their oars, so to speak, and letting people see what gravity will do to them. Still, as the result of a good many observations, I have no hesitation in saying that the action of gravity upon a *Daphnia* is to cause it to sink in practically a vertical position, as shown in Fig. 2, whereas the same force causes a *Simocephalus* to sink in an oblique position back downwards, about as shown in Fig. 5.

If the foregoing statements about the action of gravity and

the direction of the stroke of the large antennæ be taken together, it will be seen that certain results may be predicted, upon elementary mechanical principles, which should, if the facts are really as reported, be found to actually occur. Thus in considering the case of a *Daphnia* (Fig. 2), we know that the action of gravity is to pull the animal downwards with the long axis of the body in a vertical position. We also know that the direction of the stroke is oblique to the long axis, being approximately as shown by the line *m s*, and that the forward motion from this cause alone would be in the direction *s m*. The real path will therefore be represented by the resultant of these two forces. Taking gravity at about one-half of the pull exerted by the antennæ (it is probably much less as a rule, but it cannot be much more, or the animals would scarcely be able to raise themselves in the water), the actual direction of progression will be represented by the line m^1. Owing to the tendency, however, of the long axis to arrange itself parallel to the line of movement, the body of the animal will come to assume the position shown in Fig. 3, where the long axis *l a* is parallel to m^1 of Fig. 2. Now the position shown in Fig. 3 is actually about the normal position assumed by a *Daphnia* when swimming at a medium speed. It is true that all Daphnias are not precisely alike in this respect, but it is also true that all approximate more or less closely to the position shown in Fig. 3 when they are swimming normally in the water. So far, therefore, as the normal position of a swimming *Daphnia* is concerned, the facts already given, as to the action of the antennæ and gravity, seem to offer a sufficient explanation.

Looking into the subject a little deeper, it will be seen, however, that if we only take the two factors of the net result of gravity and the direction of the stroke into consideration, the animal ought not to *remain* in the position indicated in Fig. 3, but, in accordance with the reasoning already used, should tend to take up a position with its long axis parallel to the resultant of the two forces at work—*i.e.* parallel to the line m^1. As this process would necessarily be repeated again and again, the conclusion seems to follow that the real path of the animal ought to be a circle, or, to speak more correctly, a series of loops, each of which approaches more closely to a circular form, the greater the power of the antennæ compared with the action of gravity. But this is not supported by observation, for although I have

occasionally seen Daphnias turning over and over—*i.e.* swimming in approximately circular paths—this is certainly not the normal method of progression. There must be other factors at work, then, which prevent these creatures from merely moving round and round, and I do not think we need seek far for the two most important of them.

In speaking above of the effect of gravity, attention was directed solely to the force exerted upon the body as a whole. Gravity, however, not only causes the animal to sink, but also, in the case of Daphnia, tends to bring its long axis into a vertical position. This action can be easily detected if a *Daphnia* be carefully watched when not swimming very rapidly. It will then be seen that during each downward stroke of the antennæ the animal assumes a more or less oblique position back upwards, and that during the interval necessary for the raising of the antennæ the animal becomes nearly vertical again. In this way the turning effect of the action of the antennæ is very largely neutralised—in fact it is altogether checked if the movements of the antennæ are sluggish. It must also be borne in mind, in considering this straightening effect of gravity, that, owing to the distance at which it acts being increased, the force will become stronger the more the animal approaches the horizontal. Nevertheless it can readily be supposed that when a *Daphnia* uses its antennæ very rapidly the interval of time between each stroke is so much reduced that the straightening effect of gravity does not count for much, and that, therefore, the path taken by the animal should be approximately circular. Now, although it seems quite certain from observation that, as a general rule, the faster a Daphnia travels the more it tends to assume a horizontal position, and the more curved becomes its path, yet we know that the latter does not usually return upon itself. There must be then at least one other factor at work to prevent such approximately circular motion, and I think there can be no doubt that this second neutralising agent is no other than the possession of long shell-spines.

This idea is supported by several facts. For example, it is just in those species of *Daphnia* which are the most active swimmers—*i.e.* the clear-water forms—that we find the greatest development of the shell-spine, and even the additional possession of a head-spine, or an elongated head. On the other hand,

species like *D. pulex*, *D. obtusa*, *D. magna*, etc., which are comparatively sluggish in their normal movements, only exhibit short shell-spines, although even here the young, and the adult males of these forms, which are more energetic than the adult females, invariably possess much longer shell-spines than the latter. Again, in the cases where Daphnias have been seen actually turning over and over, it has always been with comparatively short-spined species, as, for example, *D. magna*.

Coming now to *Simocephalus*, it is easy to show that the known facts as to the results of gravity, and the direction of the current produced by its antennæ, are sufficient to explain its position when swimming, and the direction of its movement. When sinking quietly in the water the position assumed is as nearly as possible as shown in Fig. 5. When swimming normally the position is about as shown in Fig. 6. The increase in the obliquity both of the animal and its path is to be explained, as indicated by the diagrams, in exactly the same way as in the case of *Daphnia*, the only difference being that, as the centre of gravity in *Simocephalus* is evidently situated on the dorsal side of the long axis, the animal will swim with its back downwards. Of course the tendency for the position to become more and more oblique, and for the path to become more nearly circular, the faster the animal goes, is present here as well as in the case of *Daphnia*. And it can be verified by observation that when a *Simocephalus* does go more than usually fast it really does become more nearly horizontal, even sometimes passing that position and swimming with its head inclined downwards, whilst its path in these circumstances is distinctly curved. As, however, species of *Simocephalus* are rather heavy creatures, and not very strong swimmers, there seems to be no danger of them ever going so fast as to move round and round, even though they are not provided with the special safeguards against such unprofitable action—viz. shell-spines.

Except in the introductory paragraphs I have not alluded to *Ceriodaphnia* and *Scapholeberis*. This is because, owing to their smaller size, I have not yet made any experiments with them, either to determine the direction of the current produced by the swimming antennæ or to ascertain the effects of gravity. I have little doubt, however, that it will be found that the stroke of the antennæ in both cases is about the same as in *Daphnia*

and *Simocephalus*—*i.e.* not quite parallel to the long axis of the body, but slightly inclined towards the back; while in respect to the general effect of gravity, *Ceriodaphnia* will be found to closely resemble *Daphnia*, whereas *Scapholeberis* will resemble *Simocephalus*.

Although in the present paper I have limited myself to the swimming habits of *Daphnia* and its allies, it must not be supposed that it is only among these forms that striking differences exist. There is at least one other case among the Entomostraca, and it is even more remarkable, for the differences occur between the species of a single genus, namely, *Cyclops*. Why such species as *C. fuscus*, *C. albidus*, *C. serrulatus*, *C. prasinus*, etc., should always swim back downwards, whereas *C. viridis*, *C. strenuus*, *C. bicuspidatus*, *C. vernalis*, etc., always swim back upwards, and why, again, *C. leuckarti* should always swim vertically, is a subject which it has long been my desire to fathom. Hitherto I have not been able to satisfactorily account for these peculiarities, but I hope, when the method of examining these creatures, as indicated above, has been further developed, that we shall get some light on the matter.

Note on the Tracheal Tubes of Insects, etc.

By A. A. Merlin, F.R.M.S.

(*Read March 16th*, 1900.)

Some few years ago, while examining a balsamed preparation of the tracheæ of the *Dytiscus* larva, employing critical illumination and an apochromatic objective, it was found that the internal strengthening thread did not consist of a long, continuous fibre of equal breadth throughout, spirally wound round and round in the tube, as invariably described and figured in the text-books, but, on the contrary, the thread was seen to consist of a number of short and varying lengths, sometimes sufficing to form a couple of complete loops within the circumference of the pipe, but in many instances falling short of one complete coil.

Hoping that some one more competent than myself would take the matter up, I at the time alluded to it in a short letter to the "English Mechanic," but apparently without result.

The structure is easily observable in the tracheæ of a Trinidad centipede (*Scolopendra morsitans*). In this the chitin fibres are deeply coloured and very distinct, but, so far as my observations extend, and a considerable number of various insect tracheæ have been examined for the purpose, a precisely similar general arrangement is to be seen in all such tubes, even the smallest, although in some of the latter the lengths of the continuous thread frequently suffice for two or three complete turns, which is more rarely the case in the larger kinds.

The task of elucidating the structure referred to, in the case of *Scolopendra morsitans*, cannot be regarded as in any way a difficult one, an ordinary achromatic $\frac{1}{2}$-inch objective rendering all the existing features conspicuous, indeed they are so obvious that it is puzzling to account for the lack of truthful descriptions or engravings, and I consequently feel some diffidence in calling your

attention to structural details which, although not described in the text-books, are probably familiar to at least many of you.

The points to which I especially wish to call attention are the following :—

(*a*) The strengthening chitin fibres are coiled within the tube in very short lengths, often not sufficing to form one complete turn.

(*b*) Extremely short and narrower threads are occasionally observable between the larger fibres, extending through only a small fractional part of the tube's circumference. These may possibly indicate the manner in which the fibres are evolved during the growth of the pipe.

(*c*) The fibres are not of uniform breadth, but vary considerably, and exhibit an uneven wavy aspect.

(*d*) All the fibres towards their extremities taper off into very finely pointed and long, undulating filaments. In one instance a fibre has been seen split into two such terminal filaments.

In most mounted slides of this object, short portions of the thread are observable partially unwound and projecting from the severed ends of the tracheæ. This fact has been referred to by the old writers, but I have never seen any considerable continuous length of thread so unwound, say sufficient for several coils, as has been depicted in one work. In the centipede tracheæ, a longitudinally widely ruptured tube has been found, showing many of the filamentous terminations of the main fibres slightly disarranged and projecting entirely clear of the torn envelope.

Lastly, I may mention that the chitin fibres themselves have yielded no indications of any internal structure under an oil-immersion objective.

Note on the Imitation of Polarised Light Effects by Diffraction; an Optical Curiosity, with one or two useful Applications.

By J. Rheinberg, F.R.M.S.

(*Read April 20th*, 1900.)

Under my microscope this evening is placed a small piece of wire gauze,* appearing resplendent in colours, which change as the gauze is rotated. In certain positions of the gauze all the horizontal or vertical wires assume the same colour throughout; in other positions brilliant colours of varied hues are developed on each wire.

The colours are not the ordinary spectral or rainbow colours, and the whole is strongly suggestive of a polarised light effect, for which it would be readily mistaken by an observer, before inspection revealed that there was no polarising apparatus, and that the object was quite opaque.

What we have in reality to do with, is a diffraction effect. All that has been done is to place a straight-lined diffraction grating of 100 lines per millimeter (about 2,500 per inch) just above the objective.

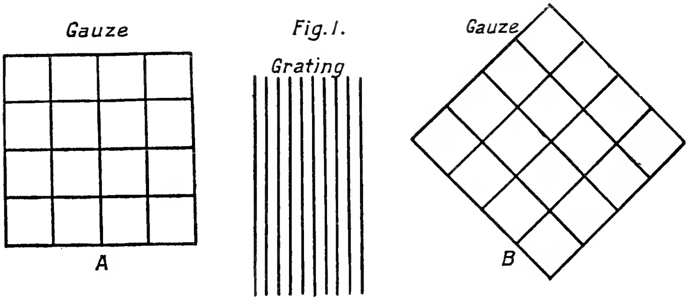
As is well known, such a grating forms an uncoloured central image of a bright line, flanked on each side by a number of spectra, violet side inwards, red outwards. In the wire gauze each space between the wires takes the place of the bright line, and forms its own white central image in the proper place, with several broadened-out spectra on each side. The spectra produced by a number of the spaces overlap and produce composite colours. When these colours fall upon the bright white image of the interspaces, they produce no observable effect, being, in fact, flooded out. Where, however, the bright colours fall upon the dark image of the opaque wires, they readily manifest themselves.

* The gauze used had wires $\frac{1}{2}$ mm. apart.

It will be seen at once that when the wires are parallel to the lines of the diffraction grating (Fig. 1 A), then, if they are spaced regularly, the colours developed upon them must be the same in each case, but so soon as the wires are rotated, then, instead of having equally wide spaces lying transverse to the grating, the width of the spaces varies in a regular manner (Fig. 1 B), and the spectra formed vary accordingly, so that we get the different colours showing themselves on the same wire.

It should be noted that for the production of brilliant effects, the magnified image of the wire gauze, or object grating, as we may call it, must bear some sort of relation to the diffraction grating over the objective. The finer the latter the coarser the former may be, and *vice versa*, so long as we employ the same objective.

Fig. 1.



There are one or two useful purposes to which the principle involved in the use of a diffraction grating over the objective adapts itself.

For instance, I have lately been making a number of experiments with wire and other gratings, and it is rather a tedious matter to measure whether the wires and interstices are evenly spaced. But if these are placed on the microscope stage, with a suitable grating over the objective, any irregularity in the spacing or ruling of the object grating reveals itself immediately to the eye in a forcible manner by reason of the different coloration of the particular wire or set of wires (or rulings) to the others. It is therefore an aid to the calibration of such gratings.

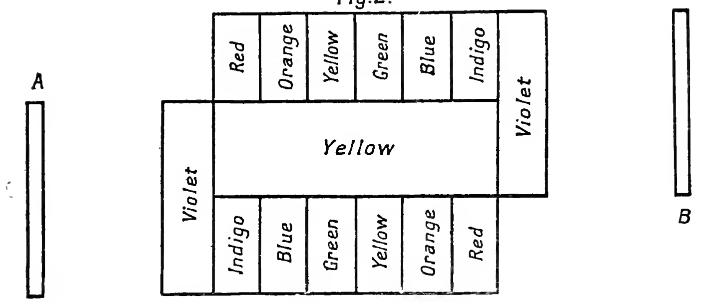
Another purpose for which the arrangement described may be used, is in investigations on colour sensation, as we can readily

obtain an admixture of two or more pure spectral colours in the *natural proportions* present in white light.

If we have a screen with two adjustable slots, we can at will cause any part of the spectrum of one to overlap the spectrum of the other, and by having the slots A and B arranged the one a little above the other (Fig. 2) the top or bottom of the field of view shows the two colours separately, which in the central part of the field form the admixture.

Of course there is nothing novel in mixing spectral colours ; the only point about this way of doing it is its great simplicity, and the fact that, since both spectra are formed by the same grating and with the same source of light, provided the two slots are of

Fig.2.



equal width, the amount of the colours mixed will be in the exact natural proportion present in the light which is being used.

A screen having two slots, which I will place under my microscope later in the evening, shows two separate spectra, nearly, but not quite, overlapping in such a way that their outer violet edges show on both sides. Almost the whole of the overlapping part shows as a canary yellow.

I have ventured to bring these experiments before you, in the belief that in their present form they are new ; if not, it will be interesting if Mr. Nelson or some other gentleman will kindly inform us on the subject.

Since the above was written I have found that the arrangement of slots extending one above the other so as to show at a glance an admixture of colours and the separate spectral colours

forming the admixture, was employed many years ago by Helmholtz, who gives a description of an elaborate slot mechanism suitable to this purpose in his "Handbuch der Physiologischen Optik," p. 353. Reference to slots used in a similar manner is also made in "Modern Chromatics" by Ogden N. Rood. Although so far, therefore, there is nothing new about the slot arrangement, it would appear that the method has hitherto only been used with prisms, I cannot find any record of gratings having been employed. The distinctive feature of the latter is that the spectra with the orders of their colours reversed can be superposed, as shown in the diagram, whilst with a prism the superposed spectra would both have their colours in the same order, *i.e.* their red ends both on the same side. The former arrangement has an obvious interest of its own because of the comparison it affords of colour sensation produced by a series of pairs of colours, each pair of which has the same mean wave-length.

Note on the Life History of the *Erysiphaceæ*.

By Ernest S. Salmon, F.L.S.

(*Read May 18th*, 1900.)

Although this group of fungi, on account of the attacks of some of its members (e.g. the Vine Mildew, the Hop Mildew, etc.) on plants of great economic importance, is more or less well known, two very important points in connection with the life-history still require investigation.

With regard to the fresh appearance of the mildew each year, the question naturally presents itself—in what way and under what conditions do the ascospores give rise every spring to the conidial or *Oidium* stage?—how do the ascospores get conveyed from the rotting perithecia on the dead leaves or humus to fresh host-plants,—the latter sometimes trees of a considerable height?

The life-history of the *Erysiphaceæ* is invariably described as consisting of two regularly alternating phases of growth,—a formation during the summer of conidia, and in the autumn of ascospores with the function of giving rise after hibernation to the conidial form again in the spring of the following year. It should be remembered, however, that in the *Erysiphaceæ* no direct proof of this regular alternation exists. Although in a few cases ascospores sown in a hanging drop of water have been observed to develop short germinating tubes, yet all attempts to infect host plants with ascospores have failed.

The suggestion may be made that perhaps in some, or even many, cases the conidia have acquired the power of hibernation; and to explain the occurrence year after year of the Vine Mildew in England,—although the perithecial stage has never been observed—some such assumption seems almost necessary. The objection that the conidia, on account of their thin walls, would be incapable of withstanding exposure to the climatic conditions of winter is unable to be maintained when it is remembered that

throughout the group of *Hyphomycetes* such thin-walled spores are the usual means of carrying the fungus through the winter.

The second gap in our knowledge of the life-history is associated with the subject of the connection of the fungus and its host-plant. In Professor Magnus' experiment of sowing conidia of the Hop Mildew (*Sphærotheca Humuli*) on leaves of the Dandelion—a host upon which in nature the perithecial form has never been found—only the conidial or *Oidium*-form of fruit was produced. It is extremely probable that on some host-plants the fungus has lost, or not yet acquired, the power of continuing its development up to the perithecial stage, as in the case of the common *Oidium* on species of *Myosotis*, *Oidium Chrysanthemi*, etc. Valuable scientific work can be done by any one with opportunities for working in the field, by taking a mildew from one species of host-plant, and attempting to grow it on other species.

In conclusion, we see that in our knowledge of the life-history of the *Erysiphaceæ* two great gaps exist: in the first place, we do not know in what way every spring the ascospores give rise to the conidial (*Oidium*) stage; secondly, we do not know to what extent each form of mildew is limited in its choice of host-plants, and whether the same species on different host-plants may not exhibit slight morphological characters correlated with its occurrence on those plants. At present these gaps in our knowledge are filled by hypotheses,—to substitute facts for these should be our aim.

Note on Ashe's Camera Lucida.

By D. J. Scourfield, F.R.M.S.

(*Read October* 19*th*, 1900.)

Some years ago my friend Mr. A. Ashe, a member of this Club, devised a camera lucida for use with the microscope, which he exhibited at one of our meetings in November or December 1889, but did not bring more definitely to the notice of members. Being convinced that the camera was a really useful piece of apparatus, I had one made according to Mr. Ashe's plan, and with this I have worked ever since. Several others have had similar cameras made, and I believe the results have always given satisfaction. Mr. Ashe has now slightly modified, and thereby improved, his original model, and it has therefore been thought of sufficient interest to bring the matter forward in a more formal way than has hitherto been done.

As will be seen from the diagram, Mr. Ashe's camera lucida is, in essence, an improved form of Beale's neutral tint reflector, the most important difference being that the light from the eye-piece, instead of being received directly upon the neutral tint glass, is first of all received upon a small mirror which reflects the light down upon the neutral tint and so up to the eye. By this means the light undergoes two reflections before reaching the eye, and the most important defect of Beale's neutral tint reflector, viz. the reversal of the top and bottom of the image without a corresponding reversal of the sides, is corrected.

But the camera now referred to does more than merely correct the partial reversal of the image produced by the simple neutral

tint reflector. By making the mirror and the neutral tint glass to rotate upon two parallel pins,* Mr. Ashe has succeeded in producing a camera which can be used in any position of the microscope. When the latter is inclined at any angle between about 45° and the horizontal, the image can be projected (only apparently, of course) vertically downwards on to the table by a suitable adjustment of the relative positions of the mirror and neutral tint glass. When the microscope is vertical (and also when inclined) the image can be projected to the side by rotating the camera 90° from its former position. The drawing-paper must now be placed on a board inclined at the proper angle, *i.e.* at right angles to the line of sight.

I may mention in this connection that it is easy to know when the drawing-board is correctly placed by observing the outline of the image of the field. If this be a circle, the angle of the board is correct. A sheet of paper with a series of concentric circles drawn upon it will enable the question of the circular outline of the field to be settled quite readily. Such a sheet of paper is also useful in determining whether the line of sight is vertically downwards, as it should be, when the camera is used, to project the image upon the table, as already described.

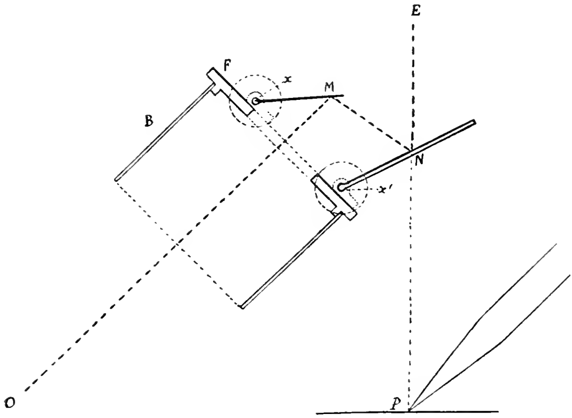
There are one or two points in connection with the construction of Ashe's camera lucida which it will be useful to mention. The most important of these is that, if the camera is to be used not only with low power, but also with moderately high power eye-pieces, the mirror must be so arranged that its free end, when the mirror is inclined at about 45°, is as close as possible to the eye-lens. This can only be done by making the mirror rather small, and pivoting it to the front plate just above the central opening in the latter.

* In the first model, only the neutral tint was movable, the mirror being fixed at an angle of 45°. This fixity of the mirror prevented the object under the microscope from being seen directly except by the removal of the camera. In the form now described the mirror can be turned up so as to allow of the object being viewed in the ordinary way, if required, without detaching the camera.

It may be interesting to note here that in 1894 Mr. Nelson, not knowing what had been done by Mr. Ashe, brought forward a camera lucida (see note "On a new Camera Lucida," *Journ. Q. M. C.*, Vol. VI., p. 39), which was practically the same as Mr. Ashe's original form, except that all the parts were rigid, and that the mirror was arranged so as to reflect the light on to a neutral tint glass placed at the side instead of below.

A second point to be noted is with regard to the kind of mirror to be used. After several trials it has been found that a small cover-glass, say, about half an inch in diameter, silvered on one side and cemented to a thin metal plate, gives excellent results, and seems altogether the simplest and most suitable form of mirror for this camera.

As regards the neutral tint glass it is necessary to make it rather large, because, owing to the adjustments which have to



B, Body of camera, fitting over eye-piece.
F, Front plate, with central aperture.
E, Eye.
M, Mirror, pivoted at x, and rotated by a milled head indicated by the dotted circle.
N, Neutral tint glass, pivoted at x^1 and rotated by a milled head.
O, Object.
P, Pencil and paper.

The above diagram shows the positions of the mirror and neutral tint glass when the camera is used with the microscope inclined at an angle of 45°.

be made for various inclinations of the microscope, the light is not always reflected from the same spot. In addition to this it is evidently essential that the whole image of the field, as seen on the drawing-paper, should be visible through the neutral tint glass.

Lastly, the tube-fitting of the camera should be made as long as possible. This allows of the camera being moved closer to or farther from the eye-piece, and thus enables the best position to be obtained for use with eye-pieces of different powers and focal lengths.

NOTICES OF RECENT BOOKS.

A Glossary of Botanic Terms. By B. Daydon Jackson, pp. xi + 327. London, 1900: Duckworth & Co. Price 6s. net.

This admirable work arrives at a very opportune moment. The enormous progress made in every department of scientific botany during the last quarter of a century has necessarily led to the invention and introduction of a host of new terms, and to hunt many of these down through the mass of scattered literature has often been an irritating and time-wasting pursuit. In this country, at least, there has hardly been any modern effort made to cope with the ever-increasing terminology; Cooke's "Manual of Botanic Terms" is, of course, now quite out of date, and Stormonth's "Manual of Scientific Terms," 2nd edit., 1885, is practically our most recent list up to the present compilation, although brief indices have appeared from time to time in scientific periodicals.

Some idea of the magnitude of Mr. Jackson's task may be gathered from the fact that the Glossary includes some 15,000 numbers, or practically three times as many as any previous work of the kind in the English language, and the labour alone involved in collecting and checking such a total must have been immense. The derivation and pronunciation are given, and this will be a boon to many; but naturally the definitions form the most important feature, and here the chief difficulty lies in the condensation. This is imperative if such a work is not to become unwieldy, and yet, if not most carefully done and deliberately and repeatedly revised, it is more apt to cause confusion than clearness. After some comparison and practical use the conclusion is reached that, although the brevity is apparent, the chief value of the book has not been to any extent impaired. That there are *no* omissions we are not prepared to say; indeed, as twenty-four pages were

added while the book was in the press there probably may be, but they are certainly few and unimportant, and Mr. Jackson must be heartily congratulated on the success of a work which for a long time has been badly wanted. It is to be hoped that the publishers will see their way to bring out a Zoological "Glossary" on the same lines, which is equally a desideratum.

G. C. K.

Agricultural Botany, Theoretical and Practical. By John Percival, M.A., F.L.S., Professor of Botany at the South-Eastern Agricultural College, Wye. London, 1900: Duckworth & Co., pp. xii + 798, with 265 illustrations. Price 7s. 6d. net.

With the increase of technical education now, at last, found to be absolutely necessary if our national industries are to hold their own in competition with the far better equipped foreigner, the need has arisen for a series of text-books which, while based upon strictly scientific models and methods as ordinarily taught, shall be adapted to the practical, every-day wants of those who, after all, intend to get their living as market-gardeners, farmers, or stock-breeders, and not as botanists or zoologists. This is, we think, sometimes overlooked by writers who have attempted to supply some of the deficiencies of the classes indicated; the strictly technical exposition has been allowed to efface the application it was meant to lead up to.

The present work is far in advance of any of its predecessors, and although Prof. Percival has not consented to lower his theoretical standard, he has throughout insisted on the necessity of observation and experiment, and, like every efficient teacher, is quite positive that real practical work is essential to the student, not alone for a proper understanding of the subject, but as a condition of his future commercial success.

The book is divided into eight parts, the first three dealing with the general morphology and physiology of plants. Parts 4, 5 and 6 are devoted to the classification and special botany of farm crops, weeds of cultivation and farm seeds; this is, perhaps, the most interesting and valuable section from the practical agriculturist's point of view, as it is to the unprofessional reader and field botanist. The remaining parts are devoted to the fungi and

bacteria, so far as these are concerned in relation to some common diseases affecting crops or with nitrification and so forth.

A very commendable feature consists in the numerous text illustrations which are entirely original and, where not simply diagrams, have been drawn by the author from living or natural specimens. Those of the grasses are particularly good, and shown of natural size, while the seeds are uniformly magnified ten diameters for easy comparison. Finally, there is a copious index.

The work throughout is excellent, and must long remain the standard English text-book on Agricultural Botany.

G. C. K.

One Thousand Objects for the Microscope, with a few hints on Mounting. By M. C. Cooke, M.A., LL.D., A.L.S. 179 pages, 13 plates, 38 figures in the text. London, 1900: F. Warne & Co. Price 2s. 6d.

Previous editions of this well-known popular handbook—the "Thousand and One Nights" of our early microscopical days—consisted entirely, in strict accordance with the title, of brief descriptions of one thousand microscopic objects. In this new edition, however, Dr. Cooke has added a preliminary part containing a considerable amount of useful information on the microscope itself and its accessories, and on the methods of collecting, examining, mounting, and storing objects. The publishers have also considerably improved the appearance of the book by printing it on larger and better paper, so that the volume before us is a decided advance on former issues, and the work will now, without doubt, prove more useful than ever to beginners in the microscopical field. Nevertheless, as Queketters, we cannot but regret that our "Father" has not taken the opportunity to carefully revise the scientific names given in the descriptive part of the book. Many of these have been obsolete for years. Even in groups which Dr. Cooke has made his own—as, for example, the fresh-water Algæ—nothing has been done to bring the nomenclature up to date. Such statements, too, as that "Four species of this genus [*Furcularia*] are recorded in Britain," "Sir John Lubbock distinguishes this [*Cyclops brevicornis*] and six other species in the Kentish ponds

as unrecognised British species," "Mr. W. S. Kent has detected nearly forty distinct British species" [of water-mites], should certainly have been revised or eliminated. The fact is, scarcely a single word or even letter of the original letterpress has been altered, for the very mistakes in spelling, such as "Drapernaldia" for Draparnaldia, "Argyroneuta" for Argyroneta, "Midgf" for Midge, have been brought forward.

D. J. S.

Hidden Beauties of Nature. By Richard Kerr, F.G.S. Second Edition; 224 pages, 59 illustrations. London, 1900: Religious Tract Society. Price 2s. 6d.

It is very satisfactory to see that it has been found necessary to issue a second edition of this extremely well got-up little book. The author's efforts to awaken an interest in microscopical studies have evidently not been altogether in vain. As was pointed out in these pages when the book was reviewed in 1895, the work is only designed for such as are almost entirely ignorant of the beauties revealed by the microscope, and judged from this point of view it will certainly hold its own with any of the popular handbooks at present before the public. The book consists of a series of short talks on such subjects as Sponges, Diatoms, Atlantic Ooze, Corals, Snow Crystals, etc.; but the most characteristic feature is undoubtedly the fine series of illustrations of the Radiolaria of the Challenger expedition. Another noteworthy feature is the chapter on fresh-water Rhizopods, with many figures taken from Leidy's splendid monograph.

D. J. S.

Chats about the Microscope. By Henry C. Shelley. 101 pages, 5 full-page illustrations, and 30 figures in the text. London, 1899: The Scientific Press, Ltd. Price 2s.

Text: Pretty good, what there is of it. Illustrations: Quite enough of them, such as they are.

Honestly, that is about all one can say for this well printed and neatly bound little book. Why such a meagre amount of

matter should have been spread out to form a book at all, and why such, for the most part, poor scratchy diagrams should have been used to illustrate it, is not at all clear. No doubt the book will serve a useful purpose if it gets into the right quarters, *i.e.* among those who have never seen a work on the microscope and microscopic objects before; but with so many other elementary books on these subjects already published there can scarcely have been any real call for the present work.

D. J. S.

Einfachste Lebensformen des Tier- und Pflanzenreiches. Naturgeschichte der Mikroskopischen Süsswasserbewohner. By B. Eyferth. Third Edition: completely revised and enlarged by Dr. W. Schönichen and Dr. A. Kalberlah. viii + 556 pages, 16 plates. Brunswick, 1900: Benno Goeritz. Price 20 marks.

Although this is called a third edition of Eyferth's "Einfachste Lebensformen," it is to all intents and purposes a new book, as it has been almost entirely re-written and very much enlarged by Drs. Schönichen and Kalberlah. Unlike Lampert's "Das Leben der Binnengewässer," reviewed in the previous number of this Journal, which gives much prominence to biological details, the work now under notice is essentially a systematic work, the bulk of the text consisting of brief descriptions of genera and species, and keys. The latter are quite a feature of the book. There are keys to the classes, keys to the orders, keys to the genera, keys to the species, and even occasionally keys to varieties. But there are also very useful, though short, introductory paragraphs to all the groups of organisms dealt with. These are confined to the simplest forms of pond-life—the Bacteria, Algæ, Protozoa, and Rotifera, though perhaps the Rotifer-lovers will hardly think that their pets should be described in this way.

The editors do not claim to have incorporated every known species in their work, as this, they think, would have made the book much too large. They have, however, endeavoured to give practically all the valid European fresh-water genera and a large proportion of the species, with an illustration of one species from each genus. In this way they have produced a book which

should be extremely useful to all those taking an intelligent interest in the study of fresh-water organisms and who would like, without going to the expense of buying the monographs on all the different groups, to be able to name the various forms they meet with, or at least to place them approximately in their respective genera. To the specialist, of course, the book, in its present form, will hardly appeal, so far as his own department is concerned.

Two suggestions may perhaps be permitted. In the first place it seems to us that in a work resting its claim to recognition almost entirely upon its usefulness in helping the student to name his specimens, a very determined effort should be made to include every known species, not necessarily of the world, but at least of some such area as Europe, for instance. This is, no doubt, for many reasons, an almost impossible ideal, and it is not surprising that the editors of the "Einfachste Lebensformen" should have decided not to strain after it. But it must be admitted that the value of a work of this sort would increase not merely in arithmetical, but in geometrical progression the nearer completeness could be approached. Should a further edition be called for, it is to be hoped, therefore, that efforts will be made to include all the known European forms.

The second point is that the addition of a few of the synonyms under which the different species are to be found in one or two of the best-known monographs, would be an extremely useful feature. It would certainly increase the value of the book for English workers with the microscope. D. J. S.

The Microtomist's Vade-Mecum: A Handbook of the Methods of Microscopic Anatomy. By Arthur Bolles Lee. Fifth Edition: xiv + 532 pages, 3 figures in the text. London, 1900: J. & A. Churchill. Price 15s.

This work is so well known to microscopists, and so much valued by them, that it is hardly necessary to refer to it here in detail. It may be pointed out, nevertheless, that the author, in issuing this fifth edition, has taken full advantage of the opportunity to very thoroughly revise the text throughout, and to include references to all the really useful methods that have been

brought forward up to the present time. Additional attention has also been devoted to the discussion of the principles underlying some of the processes described. In its present form the book is undoubtedly well in advance of any other dealing with similar subjects. D. J. S.

TASCHENBUCH DER MIKROSKOPISCHEN TECHNIK. Kurze Anleitung zur mikroskopischen Untersuchung der Gewebe und Organe der Wirbeltiere und des Menschen unter Berücksichtigung der embryologischen Technik. By Dr. A. Böhm and Dr. A. Oppel. Fourth Edition: vi + 240 pages, 2 figures in the text. Munich, 1900: R. Oldenbourg. Price 4 marks.

There are probably many workers with the microscope to whose needs this very excellent little book would be more suited than the foregoing, and even to those who possess the latter it would at times certainly be found useful. It is very portable, and yet contains a large amount of information, probably nearly three-fourths of that in the "Vade-Mecum," while in price it is not much more than a quarter that of the English work. Although, as indicated by the sub-title, the book is mainly concerned with the tissues and organs of the vertebrated animals, including man, many of the processes described are, of course, equally applicable to other animal forms. As regards "up-to-dateness," it seems to be all that can be desired.

The book is divided into two parts. In the first the various processes of fixing, imbedding, section-cutting, staining and mounting animal tissues for purposes of general investigation, are gone into very carefully. A chapter by Prof. G. Born on the methods of reconstructing particular organs, either in the form of drawings or models, from a series of sections, is added to this part. The second half of the book is devoted to the processes which are employed in special researches on particular structures, such as cells, epithelium, bone, muscle, etc., together with the methods connected with embryological work. A very useful feature is a good list of the literature dealing with the subjects discussed, by means of which it is possible to refer to the original papers for more detailed information upon special points, should this be required. There is also a very full index.

The length of many German words is notorious, but we have usually noticed that they have a tendency to end somewhat abruptly at about the twenty-second or twenty-third letter. Here is an example, however, from the book under review, which can give a couple of points to the whole alphabet: "Mikrometerschraubenschlitten." It must not be thought from this that the book is more than usually difficult for a non-German reader. On the contrary, owing to the subdivision of the text into numerous short paragraphs, a comparatively slight acquaintance with German should enable any one to make good use of the work, and we have no hesitation in recommending it to all who wish for a handy book of reference upon the modern methods of preparation of animal tissues for microscopical investigation.

D. J. S.

PROCEEDINGS.

March 16th, 1900.—Ordinary Meeting.

George Massee, Esq., F.L.S., President, in the Chair.

The minutes of the Annual Meeting of February 16th, were read and confirmed.

The President said he should like to take the opportunity of thanking the members for the honour they had done him by electing him the President of the Club. He was quite aware of the importance of the position, seeing that amongst others he was called upon to follow were such eminent botanists as Dr. M. C. Cooke and Dr. Braithwaite. He was sorry not to have been with them at their last meeting, but as most of them knew, he was absent in consequence of conditions over which he had no control. These conditions, however, were passing away, and he hoped he should not in future be absent from any of the meetings.

The following additions to the Library were announced :—

Sir E. Fry's "The Mycetozoa," from Mr. Smith.

M'Intosh's "British Annelids," Ray Society, by subscription.

"The Botanical Gazette" in exchange.

The thanks of the Club were voted to the donors.

The Secretary said he regretted to have to report the deaths of two members of the Club which had occurred since their last meeting—namely, of Messrs. J. W. Bailey and William Goodwin, also Amos Topping, the well-known mounter. Brief obituary notices of each of the deceased were then read to the meeting (see p. 440).

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Frederick J. Cheshire, Mr. Peter Lawson, F.R.M.S., and Mr. Thomas H. Underhill, M.B.

Mr. H. Morland exhibited and described an ingeniously contrived cabinet for the storing of unmounted diatoms.

The President presumed that there were still a number of people who took an interest in diatoms, and who would be sure to find this very useful contrivance of great service.

The thanks of the Club were voted to Mr. Morland for his communication.

Mr. A. A. Merlin's "Note on the Tracheal Tubes of Insects, etc.," was read by the Secretary.

The President said it seemed rather remarkable that a thing which had been known and studied for so long should have remained until now before its true structure had been understood; and considering what had already been written by others upon the subject, he thought it was just possible that in the case of some insects the structure might be different from what it was found to be in others.

Mr. Hughes said that, hearing this subject was to be brought before them, he had been looking up some old authorities on the subject; and, so far from the idea put forward in the paper they had heard that evening being new, he found that Gosse, at least forty years ago, was perfectly well aware of the facts which had just been mentioned. On the other hand, however, Rymer Jones, in his book on the Animal Kingdom, specially refers to the tracheal structure, and says that the spiral fibre was continuous throughout.

Mr. Karop said a great deal had been written about this structure, and from the examination of the trachea of Dytiscus he was certainly of opinion that Mr. Merlin's view was correct. He knew, however, the opposite opinion was held, and believed that one man went so far as to say that he had unwound several inches of the spiral fibre.

Mr. Michael said he was not aware that this subject was coming before them that evening, or he would have looked up the references to it, but he was under the impression that it was not by any means correct to say that it was generally accepted and quoted in the text-books that the spiral was formed of a continuous fibre. The non-continuous nature of the spiral structure was not only recognised by some of the German writers on the subject, but they also stated that it was not a fibre at all, but only a thickening of the wall itself; whilst others thought it was not even that. He had noticed that amongst the Acarina the spiral arrangement was common, but in the course of dissecting some of the Oribatidæ he found that though the spiral arrangement could not be seen by any microscopic adjustment, it could yet under certain circumstances be developed. In his book on

the Oribatidæ he had mentioned the fact that under ordinary conditions no special structure could be traced, but if the trachea was saturated with moisture and then put under pressure it broke up into a spiral coil. He was certainly under the impression that most of the text-books described it as a spiral thickening of the internal surface.

Mr. Hilton said he had brought a slide of the tracheæ of a silkworm, but the impression it gave him was that the spiral was simply a creasing of the inside tube. He thought this could be seen very plainly where the tubes branched. He thought this idea of the structure was confirmed by the fact that in mounting a tracheal system, when the cover-glass was pressed down, the spiral appearance disappeared just as if the pressure had smoothed out the creases.

Mr. Karop could not quite agree with Mr. Michael as to the description given in the text-books; most of those which he had referred to described the structure as having an external coat with a spiral fibre inside it. He thought they were much obliged to Mr. Merlin for bringing the subject before them.

The President, in moving a vote of thanks to Mr. Merlin for his paper, thought it had done good in drawing attention to the question, and it had raised an interesting discussion; but the probability was that the good it had done was not equal to the good it might do when the attention called to the subject had caused other observers to examine the comparative structure in various insects.

The thanks of the Club were unanimously voted to Mr. Merlin for his communication.

An exhibition of photomicrographs was then given on the screen by Mr. J. T. Holder, the series comprising a great variety of objects—insects, plant sections, sections of animal tissues, diatoms, and foraminifera, etc.—under various kinds of illumination, the descriptions of the foraminifera being given by Mr. Earland.

The President remarked that it was not possible to say much about an exhibition like the one just given them by Mr. Holder, as the subjects covered so wide a field. As far as the technique was concerned he must leave it to others who were more competent to give an opinion, but his own feeling on seeing these slides was that he should like to know very much more about

them. The idea of most persons who saw such an exhibition would probably be that the objects were simply beautiful, but he should be very glad to have the various groups shown separately, and the explanations carried out in detail. This would, he thought, be most interesting and instructive.

The thanks of the Club were then unanimously voted to Mr. Holder for his very interesting exhibition.

Meetings and excursions for the ensuing month were then announced, and the proceedings terminated with the usual conversazione.

April 20th, 1900.—Ordinary Meeting.

George Massee, Esq., F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced:—

"The Botanical Gazette"	From the Editor.
"Proceedings of the Royal Society" ...	" " Society.
"Journal of Applied Microscopy" ...	" " Publishers.
"Proceedings of the Geologists' Association"	" " Association.
"Annals of Natural History"	Purchased.
Peragallo's "Catalogue of the Diatomaceæ"	"

The Secretary said they had received from Miss Suffolk an excellent likeness of her uncle, the late Mr. W. T. Suffolk, for the Club Album.

A new folding portable microscope by Messrs. Swift & Son was exhibited and described by the Secretary. It was extremely well made and finished, the legs and stage folding so as to pack into a case 9″ × 3″ × 3″, which also contained two objectives, live box, bottles, pipette, etc., the weight of the microscope being 2 lb. 6 oz. The stage was rather larger than usually fitted to microscopes of this size, and was made to carry an Abbe Condenser. The tube was of usual Continental length, and had both coarse and fine adjustments. It was certainly one of the most delightful forms of portable microscope which it was possible to imagine.

The President thought this instrument possessed many properties which were very desirable in one which was wanted to be carried about, and there could be no doubt as to its excellence of construction.

Mr. Rheinberg read a note "On the Imitation of Polarisation Effects by Diffraction," in which he described the effects to be obtained by placing a fine ruled grating of, say, 2,500 lines to the inch, placed in the microscope above the objective.

Mr. E. M. Nelson said that devices of this kind had often been shown before in a very pretty manner, but hitherto without any practical utility, but in this paper Mr. Rheinberg had placed the idea before them in a manner which seemed likely to be of value.

Mr. Karop inquired how the grating was put over the objective, and whether it was necessary for it to be of any particular width, or fineness of ruling?

Mr. Rheinberg said it was not necessary for the ruling to be of any special width, although the fineness of the lines determined the quality of the colours. The grating was ruled upon a small circle of glass and laid upon the upper end of the objective. It need not be very wide, as the pencil of light at that point was so small in diameter.

Mr. Morland asked if by this arrangement polariscope effects could be obtained upon objects which would not polarise otherwise. Would it give them, for instance, on crystals belonging to the cubic system?

Mr. Rheinberg said it was not a polariscopic effect at all, and could only be used to any advantage upon opaque objects.

The thanks of the Club were voted to Mr. Rheinberg for his paper.

Mr. T. B. Rosseter read a paper "On the Anatomy of *Dicranotænia coronula*," a tapeworm unknown to the older helminthologists, but originally discovered by Dujardin at Rouen, and more recently found by himself in the intestine of a duck. The subject was illustrated by diagrams and specimens shown under the microscope.

The President said it was always a pleasure to listen to a paper which bore the stamp of originality, and certainly this seemed to him to be a masterpiece of research. He hoped some one acquainted with the subject would favour them with some remarks upon it.

Mr. Karop said that, as on former occasions, when Mr. Rosseter had placed his most interesting work on the structure and life-history of these avian tape-worms before the Club, the invitation to discuss the paper produced no response. The fact was that this subject was one taken up by very few in this country, and it was also one which required a large amount of patient, and, to many people, repulsive investigation; and he had often wondered at, and admired as well, Mr. Rosseter's indefatigable industry in working as he did under, to say the least, unfavourable conditions. A microscopist, however, was supposed to take the whole world for his province, and although he himself had very little experience practically of tape-worms, he was once a pupil of Dr. Cobbold, and moreover had to know for teaching purposes the very extraordinary life-history of the species infesting man and the domestic animals he used as food. Mr. Karop then gave a brief account of the metamorphoses of *Tænia saginata* and *T. solium*, as some aid to those members who, otherwise unacquainted with those entozoa, might wish to follow Mr. Rosseter's elaborate and valuable morphological paper.

Mr. Hilton asked if Mr. Rosseter could give them any information as to the manner in which development was accelerated or retarded, say by temperature or any other causes.

Mr. Rosseter said that temperature had nothing whatever to do with the matter. In the particular species he had been describing the segments were dropped into the water by the ducks, and if the eggs were taken up by a crustacean they would develop, but only up to a certain point; but if after this they were not met with by a suitable host, they died, but if taken up by a duck they would become mature in its body.

Mr. Karop asked if Mr. Rosseter knew whether the mortality amongst ducks in this country was much increased in consequence of this particular tape-worm?

Mr. Rosseter said that nothing of this kind had been recorded in this country, but there had been epidemics due to this cause reported from the Continent.

Mr. Karop, in reply to a question as to the conditions under which these tape-worms would reach their mature stage, said that unless there were two hosts it was impossible for them to mature. The chances of these conditions occurring were rather remote, and no doubt a very large number of the eggs never

reached the first host, and an extremely small proportion of those which did this ever were taken up by the proper, or second, host, in which alone they could finally develop—hence the necessity for the great number of the ova. It was the case generally that where only a very small percentage of ova ever had a chance of developing, that the number originally produced was—as in the case of fish—simply enormous.

The President was sure all present would agree that they had learnt something from the paper and remarks which followed; and when there was a ring of original research about a paper there was always a feeling of appreciation, even on the part of those who had not given any special attention previously to the subject. He had great pleasure in moving that their best thanks be given to Mr. Rosseter for his paper, which had not only been of interest, but had also combined much instruction.

Mr. Rosseter expressed his own indebtedness and thanks to Mr. Karop for the help which he had given in connection with the matter.

The proceedings then terminated.

May 18th, 1900.—Ordinary Meeting.

George Massee, Esq., F.L.S., President, in the Chair.

The minutes of the meeting of April 20th, 1900, were read and confirmed.

Mr. Max Poser was balloted for and duly elected a member of the Club.

The following donations were announced :—

"Journal of the Royal Microscopical Society"	From the Society.
"Proceedings of the Royal Society" ...	,, ,,
"Report of the Missouri Botanic Gardens"	,, The Secretary.
"Memoirs and Proceedings of the Manchester Literary and Philosophical Society"	,, The Society.
"The Botanical Gazette"	,, The Editor.

"Bulletin of the Belgian Microscopical Society"	From the Society.
"Bulletin of the Lloyd Library of Botany and Pharmacy of Cincinnati	" The Editor.

The thanks of the Club were voted to the donors.

Mr. E. S. Salmon read a paper on "New or Rare British Fungi," followed by an account, illustrated by diagrams, of the Life History of the Erysiphaceæ (see p. 411).

The President said they were much indebted to Mr. Salmon for this very interesting paper. He had succeeded admirably in exposing the weaknesses of mycologists, and perhaps it was just as well that they should know something as to where they went wrong. He hoped that Dr. Cooke, who was present, would give them some of his ideas on the subject.

Dr. M. C. Cooke said that in the first place he was not so pugnacious as he used to be half a century ago; in the next place he believed that with old age he was getting exceedingly indolent, and in the last place his hearing was not so good as it was, and therefore it was only with the greatest difficulty that he could follow the paper—not being able to hear all. He was such an old Conservative in general, and as regarded fungi in particular, that the mycologists of the present day seemed to him to be going mad in their indiscriminate multiplication of species and genera, by picking out almost a single feature and making a new species based on that alone. They now divided up what used to be thought one species into four or five, and if there was a difference of so many micromillimetres in the size of the spores, that was quite sufficient ground for these people for making a new species. He appealed to his honourable friend in the chair as to whether he had not met with specimens of Peziza in which the spores varied in size. He had obtained specimens of the same species from Germany, and also from Australia, and found that in the majority of cases those from Australia had larger spores than the European specimens. Saccardo and others would however at once ignore all other resemblances, and merely because the spores were larger, would make these new species. In the old days they used to take *all* things into consideration, and never thought they ought to consider the fruit alone as giving a specific character. The Perisporiaceæ had been well characterised and

were in his idea as compact a group for specific characters as any that could be mentioned. He had never cultivated them, because it was quite problematical whether they would produce fruit or not. As regarded the question of reproduction from conidia, he had found in other groups that they did not hibernate unless they had some thickening of the external coating to protect them from the cold; there was a provision of this kind made in the case of Perisporium, where they produced conidiospores which in the spring germinated and infected the plants on which they were found, but in the moulds they had no well authenticated instances of the delicate spores passing through the winter unless they had been previously introduced into the tissues of some host plants. He had not read all the abstruse investigations or imaginations which had been put forth on these subjects, and could therefore say little about them. He would take the opportunity of saying, however, that he was exceedingly glad to meet his old friends at the Quekett Club once more, and he hoped he should be able to join them in some of their excursions during the summer. His great feeling of regret as he looked round him was on account of seeing so few of those whom he used to meet five-and-twenty years ago; so many had in the mean time gone over to meet that great majority to which he himself should also go before long.

The President thought it would be obvious that a line of investigation had been pointed out which could be pursued with advantage, because it was clear there were things here that they did not know and which might be followed with success. Mr. Salmon had made a special study of this group, and it was always the case that in many quarters there were qualms when the old castle was being demolished and a new one erected in its place. What they really did want, however, was a good index of species which could be relied upon as well founded. At present it was no doubt the case that a man sets himself to find out all sorts of minute points, and then incorporates them into specific characters; but they did not want to make specific characters depend upon something which it took a week to see, and then nobody else could see it afterwards,—they must have broad species which could be got at without much difficulty, although after all a species was perhaps just as difficult to determine in a broad sense as if based on more minute characters, and a specific name was little more than a peg to hang the subject upon. It would

of course be to the advantage of every one to so pin down a species that there could be no difficulty in making any one understand what was being talked about without so many conditions and exceptions. The more general a species was made, the more difficult it would be to make others, and when it had been got down to the lowest point the trouble still was to get a species to fit into it because there would be always some point where it would not fit in, but from which it would branch out to some other genus, so that it was not possible in a systematic work to give the whole life history of a species. As regarded the variation in species, modern mycology was "mixed mathematics," the life history was left out altogether, and most mycologists wished these things never did live, but existed only as herbarium specimens. As to certain Australian species of fungi, there was every reason to suppose that they had been introduced from Europe, as the only species known in Australia are the same as those found here, only, as was commonly the case in Australian fungi, they had larger spores. Why this should be so no one knew, and there were many things of this kind which could not be explained or understood.

Mr. Salmon said he was very glad to hear Dr. Cooke condemning an undue multiplication of species. If they took one feature and one feature alone and made species by using this one character they at once got multiplicity of species. As regarded hibernation, he had only mentioned it as a suggestion for getting over the gap, for in the usual course the spore had a very thin wall, and, as Dr. Cooke said, it was supposed that if it did not germinate at once it died. Saccardo gave a hundred and twenty species, the majority of which were named not in accordance with morphological characters, but according to the host-plants on which they grew. A collector, for instance, would find a fungus on a rare host plant, and would name it accordingly without further consideration.

The President hoped that the paper and the discussion on it would stimulate some of their members to take up the subject, which offered good promise to those who did so.

The thanks of the Club were, upon the motion of the President, unanimously voted to Mr. Salmon for his paper.

Mr. Karop said they had another paper on the agenda, but as the time was advancing he thought it would be better to hold

this over until the next meeting. He felt sure that the few members present who remained over from the early days of the Club must be very pleased to meet Dr. Cooke—the founder of the Club—for the first time in that room, and that all would unite in giving him a very hearty welcome.

The proceedings then terminated with the usual conversazione.

June 15th, 1900.—Ordinary Meeting.

J. G. Waller, Esq., Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Library were announced :—

"The Botanical Gazette" ... ... From the Editor
"Proceedings of the Smithsonian Institution" In Exchange.

The thanks of the Society were given to the donors.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Owen Carter, Mr. Oswald A. Grosvenor, Mr. Henry Poole, Mr. Geoffrey P. Swears.

Mr. E. M. Nelson read a paper on *Actinocyclus Ralfsii*, in which he discussed the question as to the cause of the remarkable colours exhibited by this diatom.

The Chairman thought Mr. Nelson had raised a very interesting question, and one which at present seemed very difficult to answer.

The thanks of the meeting were voted to Mr. Nelson for his paper.

Mr. R. T. Lewis read a paper entitled "A Contribution to the Life History of *Ixodes reduvius*," in which he described some observations originally made by Mr. E. G. Wheler, and subsequently confirmed by himself. The subject was illustrated by diagrams, photographs and drawings, and by the exhibition under the microscope of living specimens paired in the actual manner described in the paper.

The thanks of the meeting were unanimously voted to Mr. Lewis for his paper, and to Mr. Wheler for allowing his observations to be brought before the Club.

Mr. Karop said he believed that instances had been noticed amongst the Acarina in which fertilisation was effected by a special organ, which transferred the spermatophores from the

receptacle to the female. Was it possible that this was done in any way by the rostrum?

Mr. Lewis said he was aware of this, and particularly noted that in the spiders the palpi were used for the purpose, but the most careful observation had failed to detect any such action as would lead to a suspicion that this was the case here. Certainly the palpi were not the means of transference, and the only suggestion was that there might be some internal channel by which the spermatophores were conveyed to the two villi during the connection. The great dilation and alteration in the appearance of these villi at this particular time gave the impression that they were the organs specially concerned.

A paper by Mr. Merlin on the Structure in the Bacillus of the Bubonic Plague was taken as read, and the thanks of the meeting were voted to the author.

A paper by Mr. Soar was also taken as read, it being chiefly a list of fresh-water mites collected by Mr. Taverner, near Oban. The thanks of the Club were voted to the author of this paper, which would appear in due course in the Journal, and would, no doubt, be useful for reference.

The Secretary reminded the members present that their next ordinary meeting would not be held until October 19th, but that the third Friday evenings in July, August, and September would be utilised as gossip nights.

The Chairman having wished the members a pleasant vacation, the proceedings terminated with the usual conversazione.

OBJECTS EXHIBITED, WITH NOTES.

March 2nd, 1900.

Mr. C. F. Rousselet; Cladocera from the Baltic. A very interesting admixture of marine (*Podon* and *Evadne*) and fresh-water (*Bosmina*) types.

Mr. F. Enock: Tracheal tube of larva of *Hydrophilus*, showing *discontinuity* of the internal fibre. (See "Note on the Tracheal tubes of Insects, etc.," p. 405.)

Mr. J. B. Scriven: Two sections of compound eye of Blowfly. (1) Outer limitary membrane of retina viewed vertically. (2) Transverse section of the dioptron. Each rhabdome consists of seven long cells surrounding a central lumen.

Mr. A. J. French: A Radiolarian, *Saturnulus sp.*, from "Challenger" Station 274, Central Pacific, 2750 fathoms. The characteristic features are two concentric lattice spheres, the extremities of the polar spines being joined by a circular ring.

Mr. H. Morland: Front and side views of valve of *Biddulphia fossa* Gr. and St. This species was first described by Messrs. Grove and Sturt in their papers on the Oamaru deposit in the Q.M.C. Journal about fourteen years ago.

April 6th, 1900.

Mr. G. West: A slide of *Coryne* exhibiting the extraordinary manner in which Diatoms cover all objects from the South Devon coast. All who have worked this coast must have been struck with the prodigality of Diatom life.

Mr. H. F. Angus: Parasite of Malarial Fever. The slide shows the form originally described by Laveran, and represents an advanced stage in the development of the parasite. The remains of the blood corpuscles in which the parasite developed are still visible, and the characteristic black pigment formed by the parasite from the hæmoglobin of the corpuscles is also shown.

Mr. A. E. Hilton: Tracheæ of Silkworm, showing foldings or thickenings of membrane rather than a definite continuous fibre. (See p. 405.)

Mr. H. Morland: Abnormal forms of *Melosira Dickiei*, Thwaites, showing the valves fitting into one another somewhat after the style of flower-pots. The slide is from a set of the Norfolk Diatoms mounted by the late F. Kitton.

April 20th, 1900.

Mr. R. T. Lewis: The male of the Great Cattle Tick—the "Bont Tick" of the Dutch colonists of the Cape and Natal—*Amblyomma hebræum* Koch. This Tick is one of the commonest Cattle Ticks in Cape Colony and Natal. The word "bont" is Cape Dutch for "variegated," and the animal well deserves the appellation, for the male is beautifully coloured, green, gold and purple, while the female, although in the main of a dark chocolate colour, has a purple and yellow pattern on the shield with yellow joints to the legs.

Mr. A. E. Hilton: Portion of skin of Silkworm, *Bombyx mori*, showing two spiracles, the main tube connecting the same, and the branching tracheæ.

Mr. A. Earland: Specimens of *Orbulina universa* (d'Orbigny) laid open to show the internal Globigerine shell.

The genus Orbulina is typically a hollow sphere, but if a number of specimens are laid open a few will be found to contain a more or less perfect "Globigerina" attached to the interior of the sphere by numerous very delicate spines. Hence the theory that Orbulina is only a life stage of Globigerina. It is supposed that the Globigerina for protective purposes or some unknown reason surrounds itself with a spherical shell; the early Globigerine chambers being then of no further use are gradually dissolved and absorbed, until at last the sphere becomes quite hollow (Orbulina in its typical form).

Note (1) The spines attaching the chambers to sphere. (2) The more or less eroded nature of the final chambers of the Globigerine shell. (3) The Globigerine shell visible through the external shell of the sphere in one or two of the smaller specimens.

May 4th, 1900.

Mr. W. R. Traviss: Decrepitating Quartz, from Branchville,

U.S.A., with cavities containing two fluids and a gas. The bubbles move on rotating the stage and will disappear at a temperature of 83° F. Small fragments of this quartz struck with a hammer give a sharp report.

Mr. H. Morland: Front and side views of *Triceratium spinosum* Bailey, from an artesian well boring, 406 feet deep. Atlantic City, N.J.

Mr. J. T. Holder: Transverse section through the entire stomach of a frog.

Mr. A. Earland: Miscellaneous organisms, other than foraminifera, picked out of sea soundings: Radiolaria, Sponge spicules, Mollusca, Ostracoda, Fish teeth, Bryozoa, etc.

May 18th, 1900.

Mr. A. Earland: Two varieties, long and short necked, of *Lagena lagenoides*, from Timor Sea, 50 fathoms.

Mr. J. T. Holder: Mesentery of Frog showing "pavement" epithelium. Nitrate of silver and hæmatoxylin preparation.

June 1st, 1900.

Mr. A. E. Hilton: *Spirogyra* in conjugation, showing the cells before, during, and after the passage of the contents from the male to the female filaments.

June 15th, 1900.

Mr. C. F. Rousselet: A variety of *Notops brachionus* with two spines, reared from dried mud received from Rhodesia.

Mr. R. T. Lewis: Specimens of *Ixodes reduvius*, ♂ and ♀ in copula.

Mr. A. E. Hilton: Portion of polyp of Sea-Pen, *Pennatula phosphorea,* showing extended tentacles and spicules surrounding the mouth.

July 6th, 1900.

Mr. H. Morland: *Rhaphoneis amphiceros* var. *tetragona* (formerly known as *Amphitetras crucifera*) from Madagascar. Mounted in styrax.

OBITUARY NOTICES.

It is my melancholy duty to announce the death of two members, and of one who for many years was a member of the Club.

The first is Mr. J. W. Bailey, who died on January 21st last, aged 77. He became a member so long ago as 1867, but he was probably unknown to most of you, as he rarely, if ever, attended the meetings in the later years of his life. Mr. Bailey was a mathematical instrument maker and optician; and although more concerned with theodolites and sextants than microscopes, yet he originated a very convenient portable stand with folding tripod foot, packing into very small compass, which he exhibited at the earlier soirées at University College. He was also an excellent amateur geologist and member of the Geologists' Association. A man of sterling worth and withal most modest and unassuming, Mr. Bailey's high character and kindly spirit won the regard and respect of all who enjoyed the privilege of his acquaintance.

Much better known as a very constant attendant here was Mr. William Goodwin, who died on March 8th. A member since 1877, he took an active part in the proceedings of the Club until quite recently, until, in fact, incapacitated by ill-health at the beginning of the winter. Mr. Goodwin was of an inventive turn, and many here will remember his glass-rod illuminator, his large-field revolver eyepiece, and, perhaps the most useful, a very compact lamp.

I am sure there can be few microscopists of any standing who will not learn with regret of the sudden death of Amos Topping, the mounter. He was a member of this Club from 1871 to 1887. It must be a very poor miscellaneous collection indeed which does not include some, at least, of his beautifully neat red and yellow paper-covered slides. His was a case of hereditary genius, for his father, C. M. Topping, was quite unexcelled as a mounter in his day, and obtained full recognition of his skill at the Great Exhibition of 1851. It was he who originated those wonderful balsam preparations of the Blowfly's proboscis. Amos Topping was almost equally successful in all branches of his art, and his deft hand and obliging manner will be missed by his many patrons.

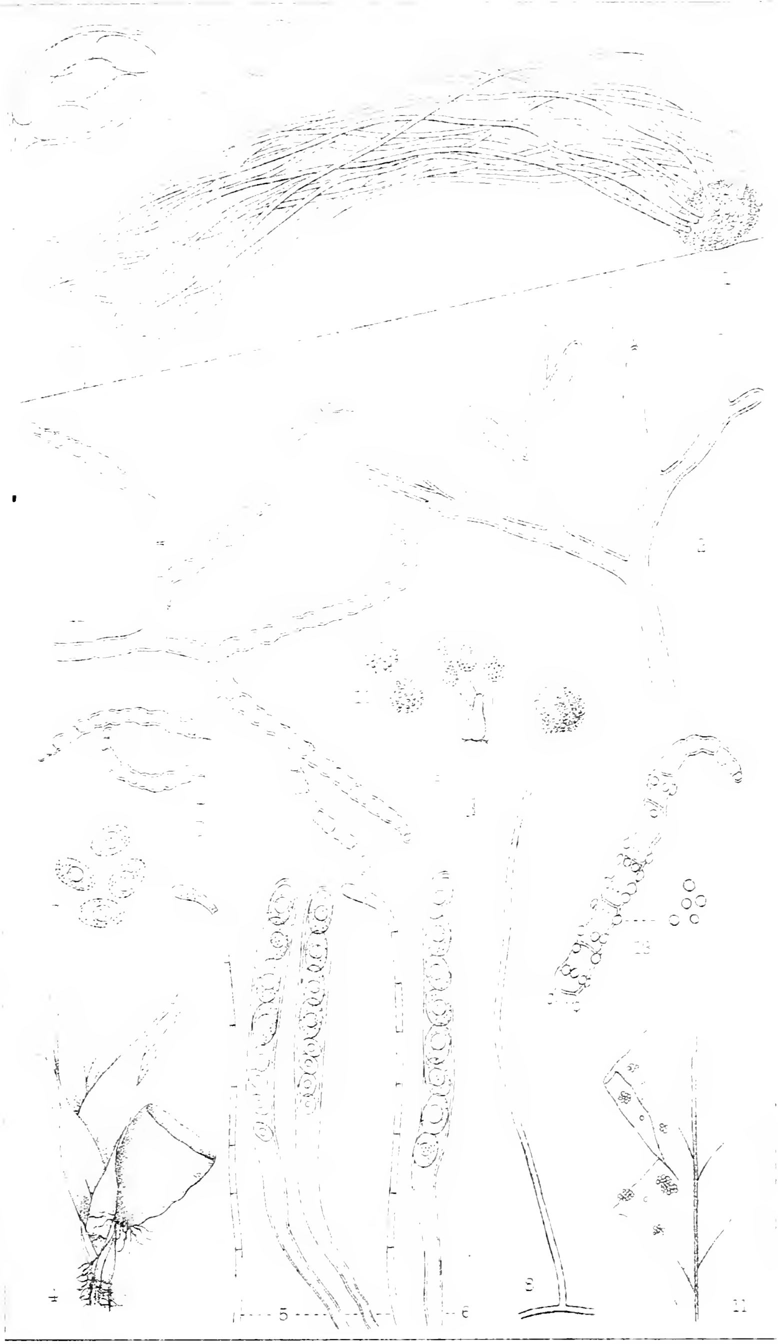
G. C. Karop.

INDEX.

T.B.Rosseter del.

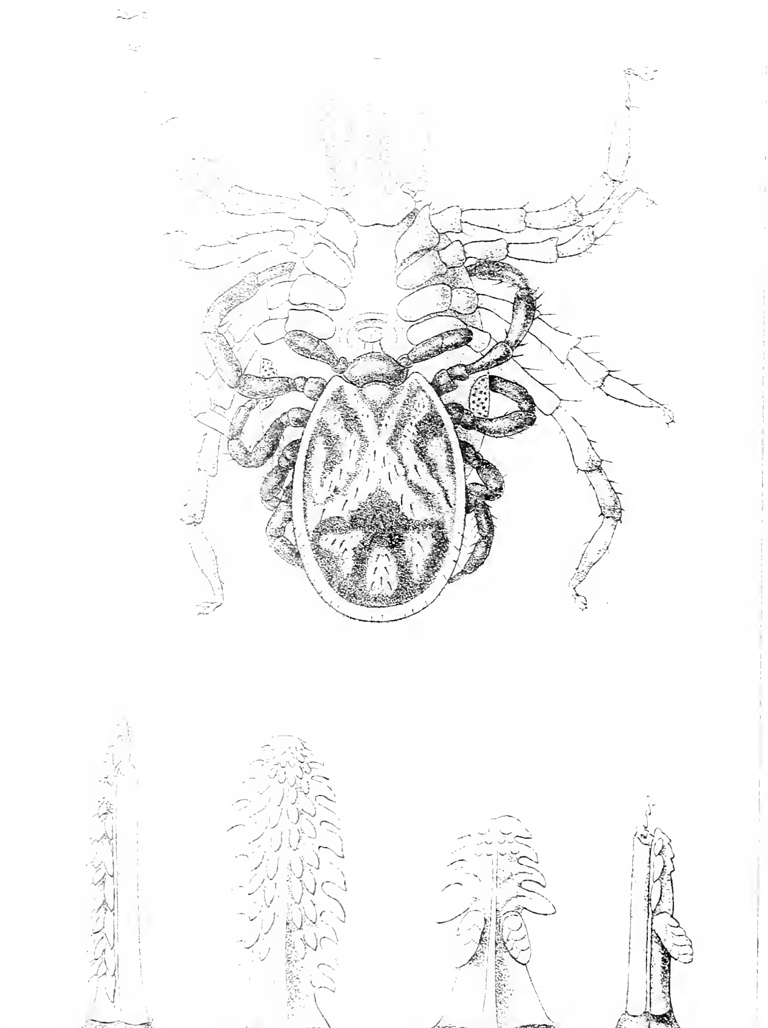
Geo. Newman lith.

Dicranotaenia coronula



E. S. Salmon del. West, Newman lith.

New and Rare British Fungi



2 4 5

Ixodes [illegible]

Ser. 2, Vol. 7, No. 42.] APRIL, 1898. [Price 3s. 6d. net.

THE JOURNAL
OF THE
QUEKETT MICROSCOPICAL CLUB.

EDITED BY

EDWARD M. NELSON, F.R.M.S.

(It will be understood that the Authors alone are responsible for the views and opinions expressed in their papers.)

CONTENTS.

London:

[PUBLISHED FOR THE CLUB]

WILLIAMS AND NORGATE,

14, HENRIETTA STREET, COVENT GARDEN, LONDON,

AND 20, SOUTH FREDERICK STREET, EDINBURGH.

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

FOR 1898-9, AT

20, Hanover Square, W.,

ON THE

FIRST AND THIRD FRIDAYS OF EVERY MONTH.

This CLUB was established in 1865 for the purpose of affording to experienced Microscopists, as well as to Students, regular and frequent opportunities of discussing those special subjects in which they are mutually interested, and also for promoting Field Excursions to the well-known collecting districts around the Metropolis.

No Entrance Fee. Annual Subscription, 10*s*., dating from January 1st.

The ORDINARY MEETINGS are held on the *Third* Friday in each Month, except July, August, and September. Business commences at 8 o'clock.

The meetings on the *First* Friday in each month, and on July 15th, August 19th, and September 16th, are for conversation and for the exhibition of objects, from 7 to 9.30 p.m.

1898.	Friday,	March	... ...	4	..	18
	,,	April	... ...	1	...	15
	,,	May	... ...	6	...	20
	,,	June	... ...	3	...	17
	,,	July	... ...	1	...	15
	,,	August	... ...	5	...	19
	,,	September	... ...	2	...	16
	,,	October	... ...	7	...	21
	,,	November	... ...	4	...	18
	,,	December	... ...	2	...	16
1899.	,,	January	... ...	6	...	20
	,,	February	... ...	3	...	17*
	,,	March	... ...	3	...	17

---

* The ANNUAL GENERAL MEETING will be held on the Third Friday in February of each year, at 8 o'clock, for the Election of Officers and other Business.